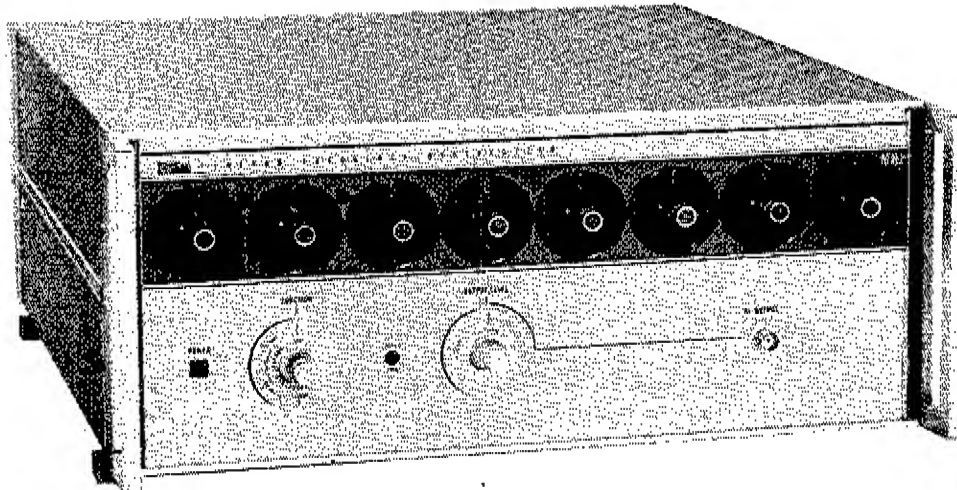


FLUKE 6160B

JOHN FLUKE MFG. CO., INC.

P. O. Box 7428
Seattle, Washington 98133



MODEL

6160B

FREQUENCY SYNTHESIZER

FOR REFERENCE PURPOSES ONLY

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Section 1

Introduction & Specifications

1-1 INTRODUCTION

1-2. The Model 6160B Frequency Synthesizer produces a selectable signal of 1 to 160 MHz in two separate ranges: 1 to 12 MHz and 10 to 160 MHz. Resolution is 0.1 Hz in the 1 to 12 MHz range and 1 Hz in the 10 to 160 MHz range. The output signal level is adjustable from +3 to +13 dBm into 50 ohms using either a control on the front panel or a dc control voltage applied to a connector on the rear panel. The output signal level will be maintained to within ± 1 db.

1-3. Output frequency selection can be done directly from the front panel or electrically through a remote connector on the rear panel. Remote control input requirements are compatible with DTL or TTL logic using BCD coding. Logic levels are as follows:

Logic "0" = 0 to +0.9V dc or contact closure to logic ground. Maximum per line current sinking requirement is 1.6 ma.

Logic "1" = +2 to +5V dc.

1-4. The synthesizer is completely solid-state and modular construction is used throughout for ease in main-

tenance. The chassis is designed for bench-top use or installation in a standard 19 inch equipment rack. Rack mounting brackets and chassis slides are available for rack mounting. Input power requirement is 115/230V ac $\pm 10\%$, 50 to 440 Hz at approximately 80 watts.

1-5. Optional features are available to meet specific applications. These options are described in Table 1-1.

Table 1-1. OPTIONS

OPTION	DESCRIPTION
-02	Internal 5 MHz Standard. 2×10^{-9} per day drift rate
-04	Rear Output. BNC output connector on rear panel.
-05	Temperature Compensated Crystal Oscillator. 5×10^{-6} per year drift rate.

1-6. SPECIFICATIONS

FREQUENCY

RANGES	1 MHz to 12 MHz	10 MHz to 160 MHz
INCREMENTS	0.1 Hz	1 Hz
SELECTION	Front panel rotary switches, remote BCD-TTL or DTL positive true logic or contact closures. Logic "0" = 0 to +.9V dc. Logic "1" = +2 to +5V dc, or open circuit.	

SPURIOUS OUTPUTS

NON-HARMONIC	Greater than 83dB (to 100dB) below fundamental. See Figure 1-1.
HARMONICS	Greater than 25dB below fundamental. (Typically >30 dB)

SIGNAL TO NOISE RATIO (TYPICAL)

(Including the effects of the internal standard)

PHASE	Greater than 62 dB	Measured in a 30 kHz band excluding a 1 Hz band centered on the fundamental, for dialed frequencies from 80 MHz to 160 MHz. Improvement in signal to phase noise ratio is seen for lower frequencies.
AMPLITUDE	Greater than 94 dB	
SYNTHESIZER RESIDUAL (Internal noise from 5 MHz input to synthesizer output)		
PHASE	Greater than 74 dB	
AMPLITUDE	Greater than 94 dB	

PHASE NOISE SPECTRAL DENSITY

Guaranteed SSB S/N ratio at the synthesizer output measured in a 1 Hz bandwidth. Valid for dialed frequencies from 80 MHz to 160 MHz. Improvement for lower selected frequencies.

OFFSET FREQUENCY	GUARANTEED S/N
1.2 kHz	>115dB
32 kHz	>121dB
600 kHz	>135dB

OUTPUT VOLTAGE

1 MHz - 160 MHz	Adjustable from +3 dBm to +13 dBm into 50Ω (.3V to 1V rms) with front panel control or external dc voltage. Level maintained ±1 dB into 50Ω
---------------------------	---

SWITCHING TIME Less than 800μsec to be within 50 Hz of final frequency.

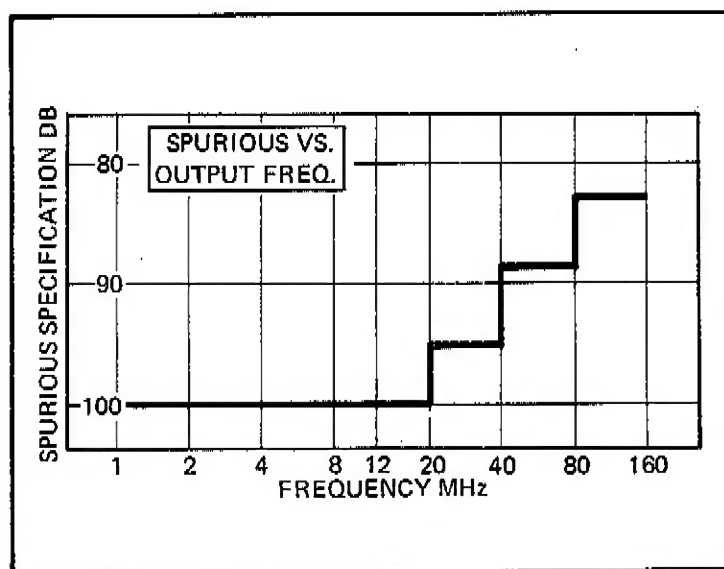
INTERNAL FREQUENCY STANDARD (Optional) 5 MHz

OPTION	AGING RATE	TEMPERATURE STABILITY
-02	±2 X 10 ⁻⁹ /Day	1 X 10 ⁻⁸ , 0°C to 50°C
-05	5 X 10 ⁻⁶ /Year	1 X 10 ⁻⁶ , 0°C to 50°C

AUXILIARY OUTPUTS 5 MHz at nominally 1V rms into 50Ω-

AUXILIARY INPUTS

Reference Frequency	5 MHz @ 0 dBm to +16 dBm into 50Ω
External Level Control	0.1 to 0.8 VDC nominal into > 2 kΩ

**NOTE**

Power line related spurious may exceed these specifications when unit is powered from 50 Hz, high line voltage source.

Figure 1-1. NON-HARMONIC SPURIOUS PERFORMANCE

POWER REQUIREMENTS	115/230V rms $\pm 10\%$ selectable by rear panel switch, 50 - 440 Hz, 80 watts.
DIMENSIONS, WEIGHT	Standard 19" (48.3 cm) relay rack width, 7" (17.8 cm) high, 20" (50.8 cm) behind front panel, 45 pounds (21 kg). Slides and rack mounting kit optional (See outline drawing, Figure 1-2).
ENVIRONMENTAL	
OPERATING	0 to 50°C, 0 to 80% RH, 0 to 10,000 feet.
NON-OPERATING	-62°C to +70°C, 0 to 50,000 feet.

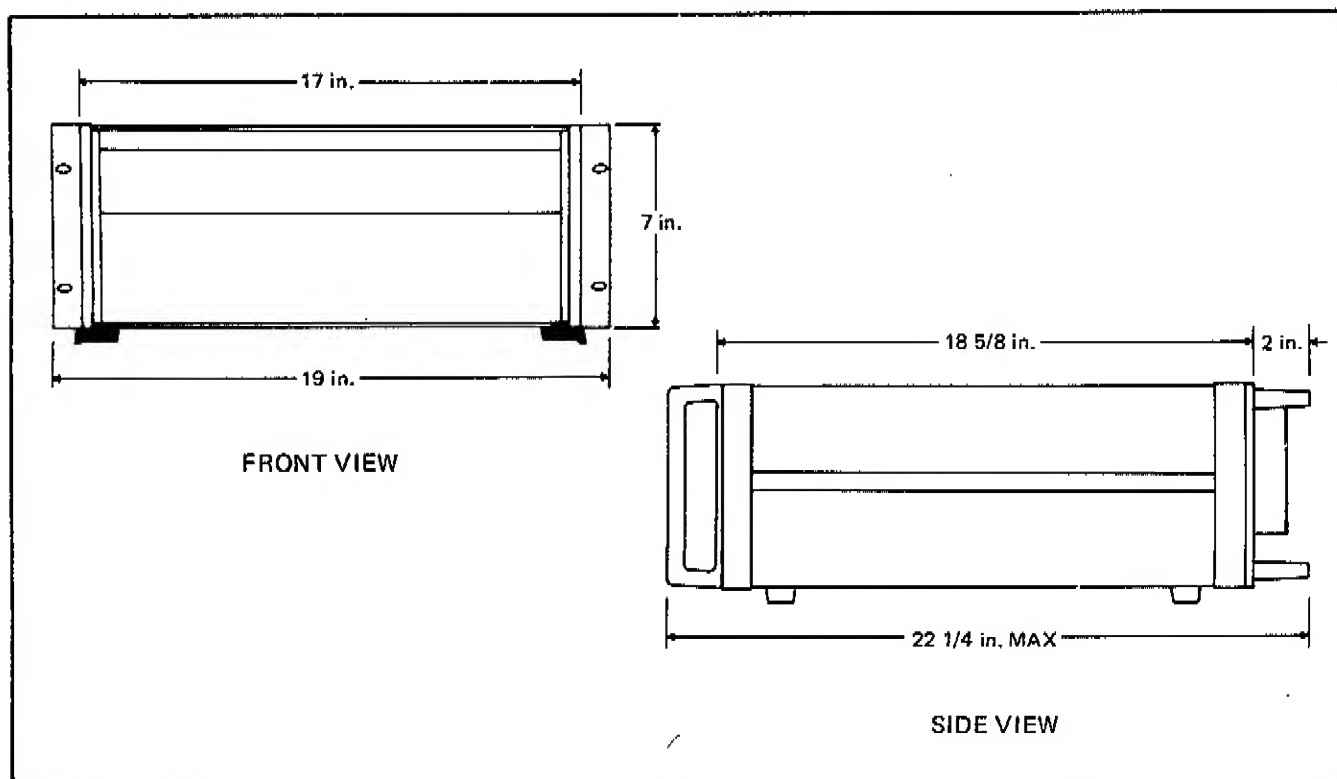


Figure 1-2. OUTLINE DRAWING

Section 2

Operating Instructions

2-1. INTRODUCTION

2-2. This section contains information essential for correct operation of the Model 6160B. Should any difficulties be encountered during operation, please contact the nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc. A complete list of Sales Representatives is located at the rear of this manual.

2-3. SHIPPING INFORMATION

2-4. The Model 6160B was packaged and shipped in a foam packed cardboard carton. Upon receipt, a thorough inspection should be performed to reveal any damage in transit. Special instructions for inspection and claims are included in the carton.

2-5. If reshipment is necessary, the original container should be used. If it is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the Model number when requesting a new container.

2-6. INPUT POWER

2-7. The synthesizer can be operated from either a 115 or 230V ac, 50 to 440 Hz power line. A slide switch on the rear panel allows selection of the appropriate line voltage. The rated value of the two fuses on the rear panel are as follows:

115VAC

230 VAC

1½A SLO BLO

¾A SLO BLO

2-8. INSTALLATION

2-9. The synthesizer is designed for bench-top use or it can be installed in a standard 19 inch equipment rack with the mounting brackets shown in Figure 2-1 and 2-2. Rack mounting is done as follows:

- a. Peel the decals shown in Figure 2-1 from the front corner castings.
- b. Remove the screws from the front corner castings which match the hole patterns in the rack mounting brackets.
- c. Attach the rack mounting brackets to the corner castings with #8-32 PHP screws.

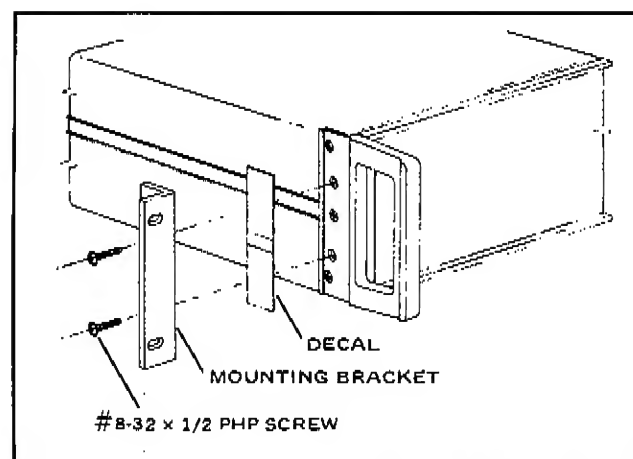


Figure 2-1. RACK MOUNTING BRACKET
INSTALLATION (M07-205-600)

- d. Peel the center side panel decals from the synthesizer.
- e. Attach the chassis section (B) to the side panels with the screws (C) provided in the kit.
- f. Install the cabinet sections (E) and center sections (D) in equipment rack. The extension angle brackets, which are part of section (E), are mounted at the rear of the cabinet.
- g. Slide the center sections (D) toward the front of the cabinet until they lock in place.
- h. Depress the spring locks on the chassis sections (B) and insert the synthesizer between the extended center sections (D) on the cabinet.
- i. Slide the synthesizer completely into the equipment rack and secure it in place with fasteners through the rack mounting brackets.

2-10. OPERATING FEATURES

- 2-11. The location and function of all controls, connectors, and indicators is shown in Figure 2-3.

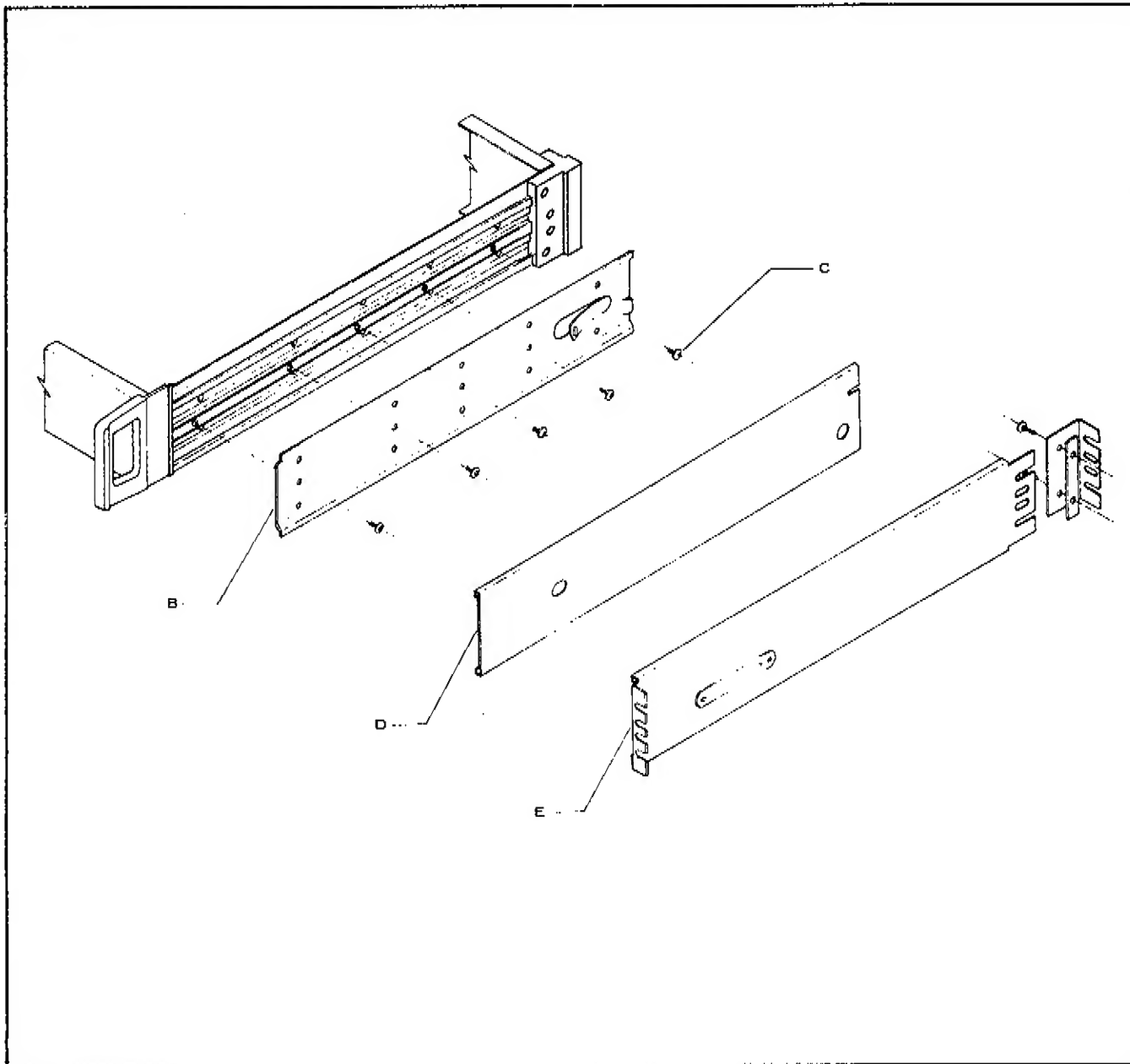
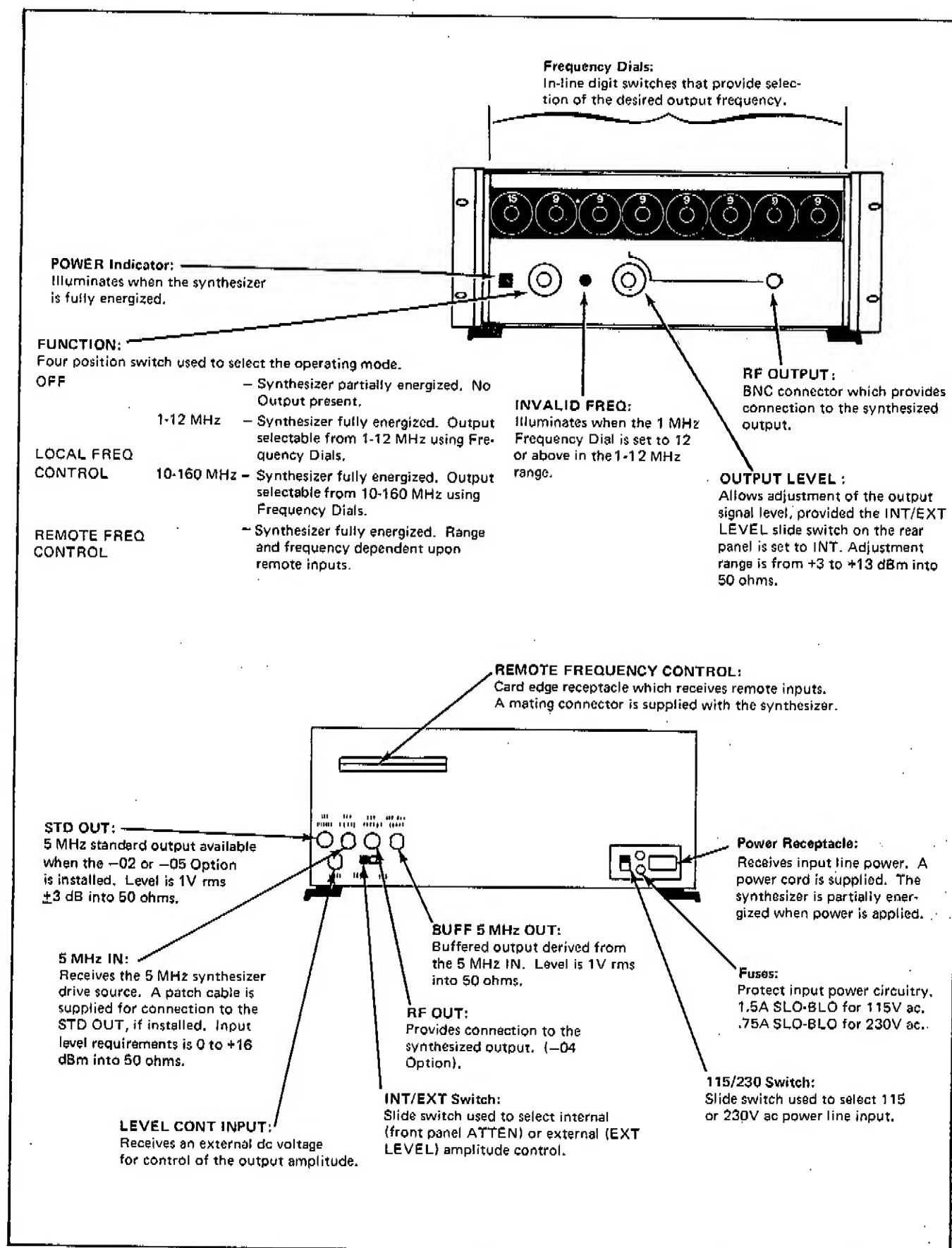
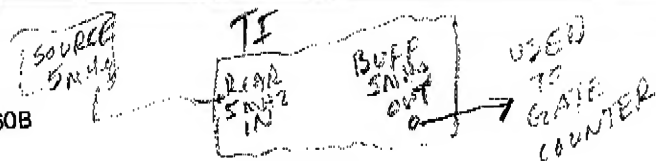


Figure 2-2. CHASSIS SLIDE INSTALLATION (MOO-280-610)



6160B



2-12. OPERATING NOTES

2-13. AC Line Connection

2-14. The input power cord has a three prong, polarized plug. This plug allows connection to either a 115 or 230V ac, 50 to 500 Hz, single phase power line. The round pin on the plug connects the chassis to earth ground, therefore ensure that it is connected to a high quality earth ground.

2-15. The synthesizer is partially energized when the power cord is connected to line power. This is done to provide continuous operating voltages for the oven of the Internal Frequency Standard (-02 Option) should it be installed.

NOTE!

Line power must be applied for at least 72 hours before the specified frequency stability of the -02 Option Internal Frequency Standard is obtained.

2-16. Drive Source

2-17. A 5 MHz reference signal is required as a drive source. Input signal level requirements is 1V rms ± 3 dB into 50 ohms. This signal is applied to the 5 MHz INPUT connector on the rear panel. A buffered 5 MHz signal derived from the drive source is available at the BUFF 5 MHz OUTPUT connector.

2-18. When the -02, or -05 Option is installed, a reference drive signal is available at the STD OUTPUT connector. A patch cable is included for connection to the 5 MHz INPUT connector. If an external drive signal is used, care should be exercised in transmitting the signal to the synthesizer to avoid contamination by hum and noise.

2-19. External Amplitude Control

2-20. Provisions have been made to allow the use of an external dc voltage to control the output signal level of the synthesizer. A LEVEL CONT INPUT connector on the rear panel receives the dc voltage. Selection of this feature is through an INT/EXT slide switch also located on the rear panel. Range of the external amplitude control is +3 to +13 dBm. The dc control voltage level is approximately equal to rms level of the rf output. Input resistance at the INPUT connector is > 2 kilohm.

2-21. OPERATIONAL TESTS

2-22. The following tests can be used to initially verify operation of the synthesizer. Required test equipment is as follows:

1. Frequency Counter Fluke 1952A-07-09
2. RF Voltmeter HP411A
3. BNC "T"
4. 50 ohm in-line compensated load
5. 50 ohm coax cable

- a. Set the 115/230 slide switch to appropriate power line voltage. Refer to paragraph 2-6 for fuse ratings.
- b. Connect power cord to line power. Refer to paragraph 2-13 grounding information.
- c. Apply 5 MHz drive signal to 5 MHz INPUT connector. Refer to paragraph 2-15 for input requirements.
- d. Set INT/EXT slide switch to INT.
- e. Set the FUNCTION switch to 1 - 12 MHz. POWER indicator on the front panel should be illuminated.
- f. Set Frequency Dials to 1.0000000.
- g. Set OUTPUT LEVEL to +3 dBm position.
- h. Connect rf voltmeter through 50 ohm in-line load to RF OUTPUT connector.
- i. Rotate OUTPUT LEVEL control throughout its range, observing that output signal level is adjustable from +3 to +13 dBm.
- j. Set OUTPUT LEVEL control to provide a +13 dBm output.
- k. Rotate Frequency Dials throughout frequency range, observing output level is +13 dBm ± 1 dB.
- l. Set FUNCTION switch to 10 - 160 MHz, observing decimal lamp shifts one decade to the right, and repeat step f.

- m. Disconnect rf voltmeter.
- n. Connect frequency counter through 50 ohm coax cable to RF OUTPUT connector. Switch in 50 ohm internal load of counter, if available. If counter is not equipped with internal 50 ohm load, connect an external 50 ohm load to counter input connector.
- o. Gate counter externally with signal derived from synthesizer frequency standard.
- p. Rotate each Frequency Dial throughout its range, observing that a corresponding output frequency is present.
- q. Set FUNCTION switch to 1 - 12 MHz and repeat step p.

2-23. If the preceding test conditions were obtained, the synthesizer can be considered fully operational. The test equipment can be disconnected and the synthesized output used as desired.

2-24. OPERATION

2-25. Frequency Selection

2-26. Selection of the desired output frequency is done from the front panel or remotely with programming inputs to the REMOTE FREQUENCY CONTROL connector on the rear panel. A FUNCTION selector on the front panel selects manual or remote mode of operation. Manual operation is in effect when the 1 - 12 MHz or 10 - 160 MHz position is selected. The desired frequency is then selected and indicated using the Frequency Dials. Maximum output frequency is 11.999999 MHz in the 1 - 12 MHz range and 159.999999 MHz in the 10 - 160 MHz range. If the most significant decade is dialed to 12 or above in the 1 - 12 MHz range, an incorrect output will be indicated by the INVALID FREQ indicator on the front panel. Remote operation is in effect when the FUNCTION selector is set for REMOTE FREQ CONTROL. Remote operation is described in paragraph 2-31.

2-27. Amplitude Control

2-28. The output signal amplitude is adjustable from +3 dBm to +13 dBm into 50 ohms using a front panel OUTPUT LEVEL control or a dc control voltage applied to the LEVEL CONT INPUT connector on the rear panel. An INT/EXT slide switch on the rear panel selects the desired

control feature. The OUTPUT LEVEL control on the front panel is in effect when the slide switch is set to INT. The external dc control voltage is selected when the slide switch is set to EXT. Input requirements for the external dc control voltage are described in paragraph 2-19.

2-29. Fixed Output

2-30. A fixed 5 MHz output signal is available at the BUFF 5 MHz OUTPUT connector on the rear panel. This signal is derived from the reference drive source input. The level is preset to nominally 1V rms into 50 ohms.

2-31. Remote Control

2-32. Control of the output frequency and range is possible through a REMOTE FREQUENCY CONTROL connector on the rear panel. Interface between the programming equipment and the synthesizer is provided through an Amphenol (261-10022-201-50001) mating connector supplied with the synthesizer. Figure 2-4 lists and describes each terminal of the connector.

2-33. Programming input requirements are compatible with DTL or TTL logic using BCD coding. Logic "0" is 0 to +0.9V dc or logic ground. Logic "1" is +2 to +5V dc. Logic ground is available at terminals 6, 7, and 8 of the connector.

NOTE!

Logic levels are defined without specifying a maximum digital noise factor of 0.5V. If noise is to be considered, then Logic "0" should be 0 to +0.5V dc or logic ground, and Logic "1" should be +2.5V to +5V dc.

2-34. Remote control is activated by placing the FUNCTION selector on the front panel to REMOTE FREQ CONTROL position. Presence of a Logic "0" at terminal 5 of the rear panel connector selects the 1 - 12 MHz range. A Logic "1" at this terminal selects the 10 - 160 MHz range. BCD inputs at terminals 10 and 13 through 44 control selection of the output frequency. All decades can be programmed to a maximum of 9 (8 + 1). Inputs above 9 will cause an invalid output.

TERMINAL	FUNCTION	
1	POWER FLAG:	LOGIC "0" = POWER OFF LOGIC "1" = POWER ON
2	SPARE	
3	{	KEY
4		
5	RANGE:	LOGIC "0" = 1-12 MHz LOGIC "1" = 10-160 MHz
6	{	LOGIC GND
7		
8		
9	SPARE	
11	REMOTE FLAG:	LOGIC "0" MANUAL LOGIC "1" = REMOTE
12	SPARE	
	BIT	DECADE (RANGE)
		100 MHz (10-160 MHz)
10	1	10 MHz (1-12 MHz)
14	1	1 MHz (1-12 MHz) 10 MHz (10-160 MHz)
13	2	
16	4	
15	8	
18	1	100 kHz (1-12 MHz) 1 MHz (10-160 MHz)
17	2	
20	4	
19	8	
22	1	10 kHz (1-12 MHz) 100 kHz (10-160 MHz)
21	2	
24	4	
23	8	
26	1	1 kHz (1-12 MHz) 10 kHz (10-160 MHz)
25	2	
28	4	
27	8	
30	1	100 Hz (1-12 MHz) 1 kHz (10-160 MHz)
29	2	
32	4	
31	8	
34	1	10 Hz (1-12 MHz) 100 Hz (10-160 MHz)
33	2	
36	4	
35	8	
38	1	1 Hz (1-12 MHz) 10 Hz (10-160 MHz)
37	2	
40	4	
39	8	
42	1	0.1 Hz (1-11 MHz) 1 Hz (10-160 MHz)
41	2	
44	4	
43	8	

REMOTE FREQUENCY CONTROL

(TOP)

2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44
1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43

(BOTTOM)

Figure 2-4. REMOTE FREQUENCY CONTROL CONNECTOR TERMINALS

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section contains the theory of operation for the Model 6160B Frequency Synthesizer. The theory description is presented first in a simplified block diagram description then a functional block diagram description, followed by circuit descriptions. A complete set of schematic diagrams is contained at the rear of the manual.

3-3. The 6160B Frequency Synthesizer generates discrete frequencies from 1 MHz to 160 MHz (159.999999 MHz) in two ranges. One range is from 1 to 12 MHz and provides 0.1 Hz resolution. The other range is from 10 Hz to 160 MHz with 1 Hz resolution.

3-4. The synthesis technique used is the indirect method. This method employs voltage controlled oscillators (VCO) and phase detectors in phase locked loop arrangements which are referenced to a frequency standard. The arrangement insures accurate and stable output frequencies with low spurious signals and very low phase noise.

3-5. SIMPLIFIED BLOCK DIAGRAM DESCRIPTION

3-6. A simplified block diagram of the 6160B is illustrated in Figure 3-1. As shown in the diagram, the 6160B can be divided into five basic blocks; Computer, Digit Generator, Output Divider, Frequency Standard, and Input Filter. The synthesis process occurs within the Digit Generator and Output Divider. Front Panel or Remote control BCD commands are processed by the Computer and applied to the Digit Generator. These BCD digit commands direct the Digit Generator to produce discrete frequencies corresponding to each frequency dial

selected on the front panel. These frequencies are combined to provide a coherent output from 80 to 160 MHz. The 80 to 160 MHz signal is applied to the Output Divider. Under commands by the Computer, the Output Divider divides the input frequency by 1, 2, 4, 8, 10, 20, 40, or 80 to yield the frequency selected on the front panel frequency dials (or remote control). Stability and accuracy of the output signal is based on the Frequency Standard. The standard may come from an external 5MHz source or from one of the internal crystal oscillator options (6160B-02, or -05). The 5 MHz signals from the Frequency Standard is applied to the Input Filter where it is buffered and processed to provide a TTL level square wave output. This TTL output is applied to the Digit Generator as a reference for producing discrete frequencies.

3-7. FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

3-8. The following paragraphs describe operation of the synthesizer using the 6160B Block Diagram, Drawing No. 6160B-1501, located at the rear of the manual. Supplemental block diagrams will be used during this description. These drawings are given figure numbers and occur in the following text.

3-9. Frequency Standard

3-10. The master oscillator for the frequency synthesizer can be either an external or internal 5 MHz standard. The internal standard is available in two options. One of these self-contained 5 MHz crystal oscillators is available as the -02 Option with 2×10^{-9} per day drift rate. The

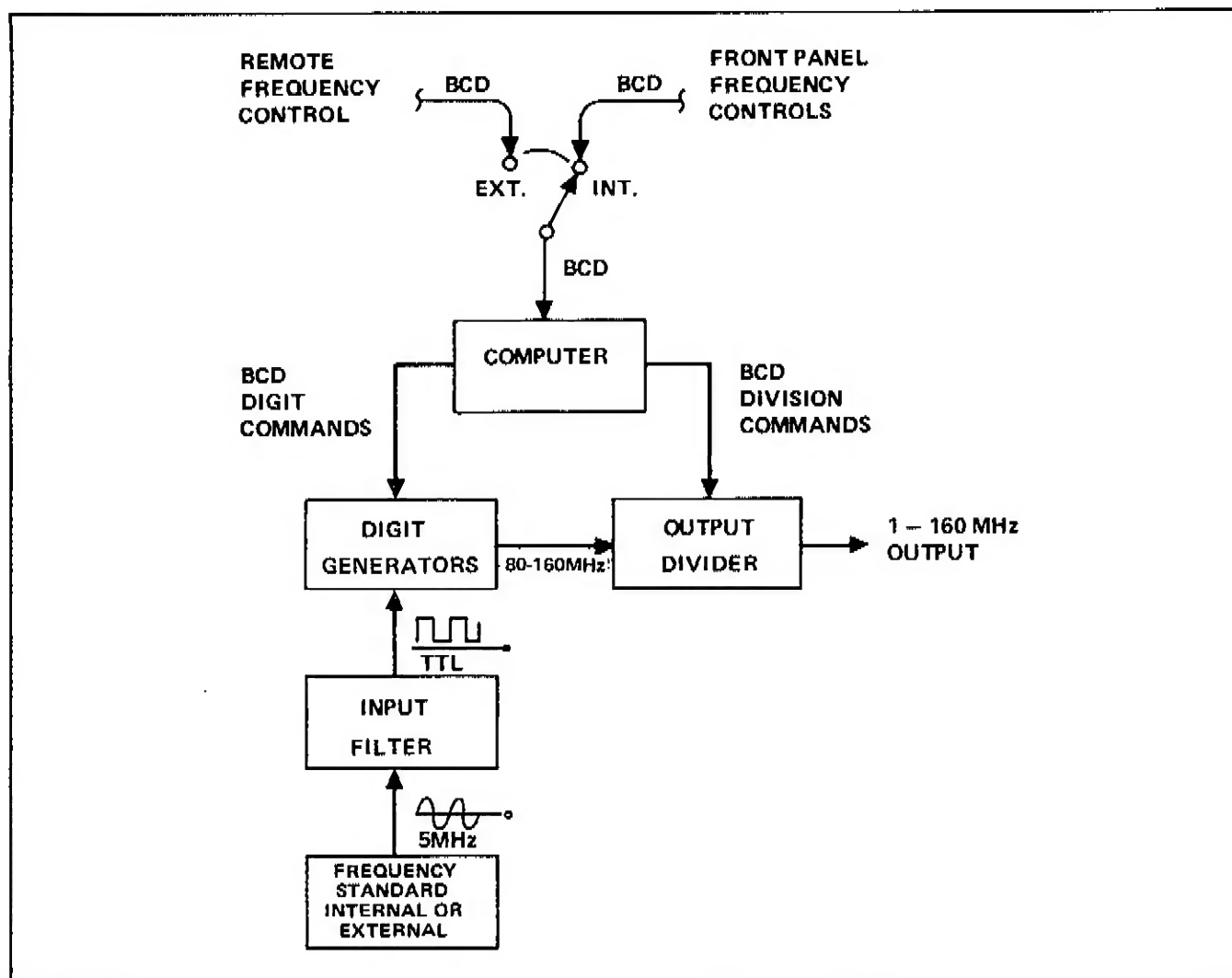


Figure 3-1. 6160B SIMPLIFIED BLOCK DIAGRAM

-02 option utilizes an oven for temperature control. The -05 option is a temperature compensated crystal oscillator (TCXO) with 5×10^{-6} per ^{YEAR} drift rate.

3-11. Input Filter

3-12. The Input Filter conditions and distributes the 5 MHz Frequency Standard signal. This signal is buffered, filtered, and amplified to provide two 5 MHz signals. It also incorporates a X2 multiplier to provide a 10 MHz signal. One of the 5 MHz signals is preset to a level of 1 Vrms into 50 ohms and made available at the BUFF 5MHz OUT connector on the rear panel. The other 5 MHz signal is distributed to the 1 MHz Digit Unit (D.U.) Step Loop, (6160B-4153-1) for a reference. The 10 MHz signal is applied as a reference to the 10 MHz D. U. Step Loop Phase Detector (6160A-4106-1).

3-13. The 5 MHz signal to the 1 MHz Digit Unit Step Loop module is divided to 1 MHz by a 5/1 divider. This signal functions as a reference for the 1 MHz D. U. Step Loop. It is also applied to the Six Digit Generator (6040A-4102) where it is buffered and applied to the Computer as a clock signal. The 1 MHz reference undergoes further division for use within Six Digit Generator.

3-14. Computer

3-15. The frequency control Computer (6160B-4012) generates internal frequency control commands from manual or remote synthesizer frequency control inputs. Manual inputs are from the front panel frequency controls. Remote inputs are from the REMOTE FREQUENCY CONTROL connector on the rear panel. These inputs are multiplexed serial by decade, processed, and then converted to parallel digital commands that establish correct synthe-

sis conditions necessary to obtain the preselected output. A simplified diagram of the Computer is shown in Figure 3-2. A formula given in this illustration can be used to determine what digital output commands are generated for any preselected input.

3-16. Input commands from the front panel or rear panel are applied to the multiplexers. The band logic decodes input to 10 MHz digit information and selects the appropriate x1, x2, x4, or x8 gates. Range commands are applied with the band commands to the Output Divider to select dividers and gates in that module.

3-17. A 1 MHz clock input controls the parallel to conversion process. This input signal is applied to the load generator and divided by two to drive the address generator. The address generator produces binary address data to the multiplexer and address converter. The multiplexers serially transfer the parallel synthesizer frequency control BCD inputs in 1 Hz to 10 MHz decade order to the first x2 multiplier and the x1 gates. The output of the first x2 multiplier is applied to the following x2 multiplier as well as the x2 gates. The output of the second x2 multiplier is applied to the x4 gates as well as the final x2 multiplier, which produces the x8 output. Carry outputs

are sequentially applied to the following multiplier by the carry "A" and "B" storage circuits. Carry load commands are derived from the load generator. The multiplied and gated serial by decade BCD information is then applied to the 1 MHz and 10 MHz storage circuits and x2 Multiplier. Conversion of the serial information to parallel format is done in the storage circuits. These circuits are addressed in sequence with each decade transfer period by control commands from the address converter.

3-18. Digit Generator

3-19. Figure 3-3 illustrates the composition of the Digit Generator discussed in the Simplified Block Diagram description. Frequencies for the six lower order decades, 1 Hz through 100 kHz, are produced in the Six Digit Generator. Frequencies for the 1 MHz and 10 MHz decades are produced in the 1 MHz and 10 MHz Digit Generators, respectively. The same basic circuit arrangement is used in each generator and will be described in the following paragraph. Afterwards, each of the generators will be described separately.

3-20. Figure 3-4 illustrates the basic phase lock loop circuit arrangement used for each decade in the generators.

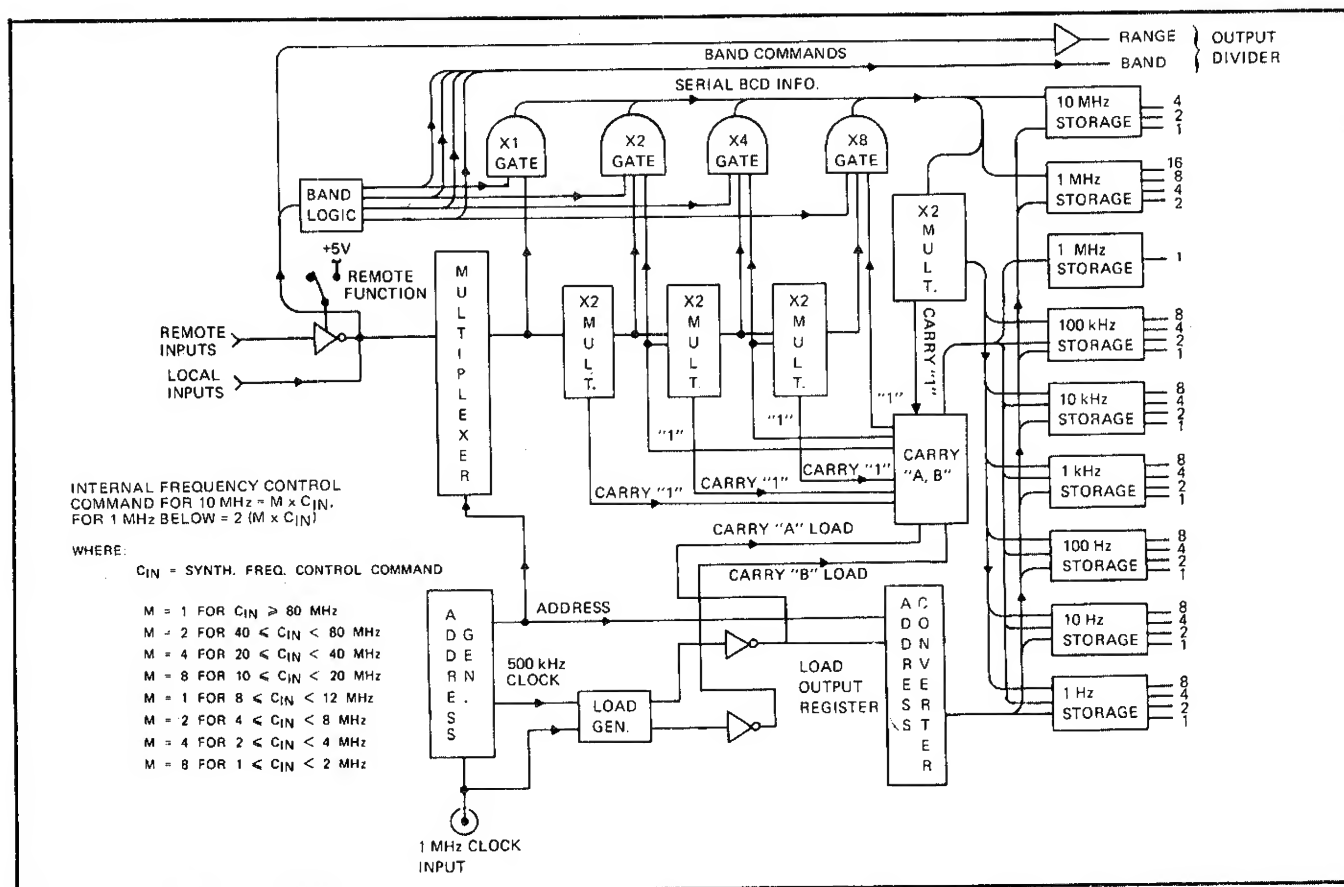


Figure 3-2. FREQUENCY CONTROL COMPUTER

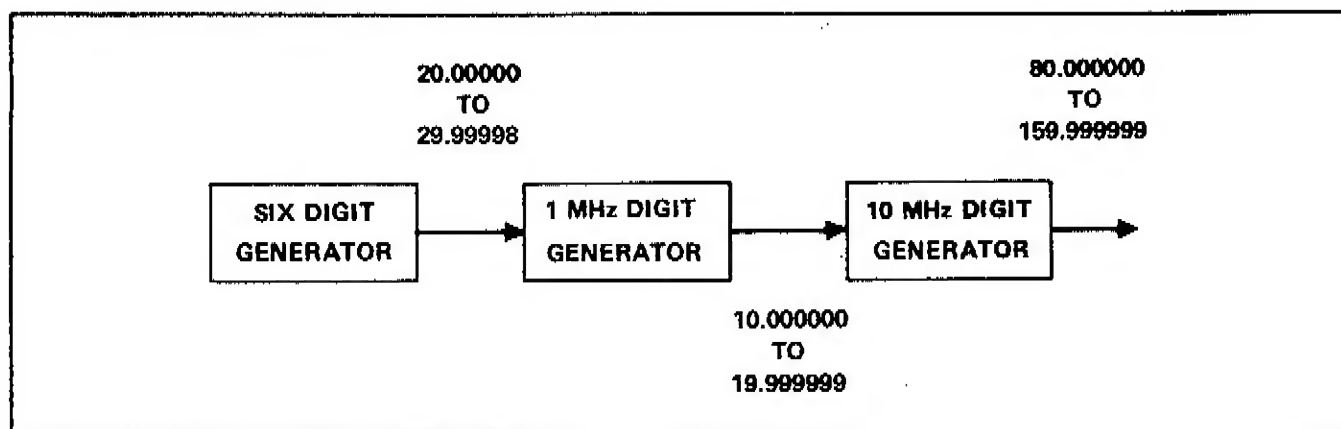


Figure 3-3. DIGIT GENERATORS

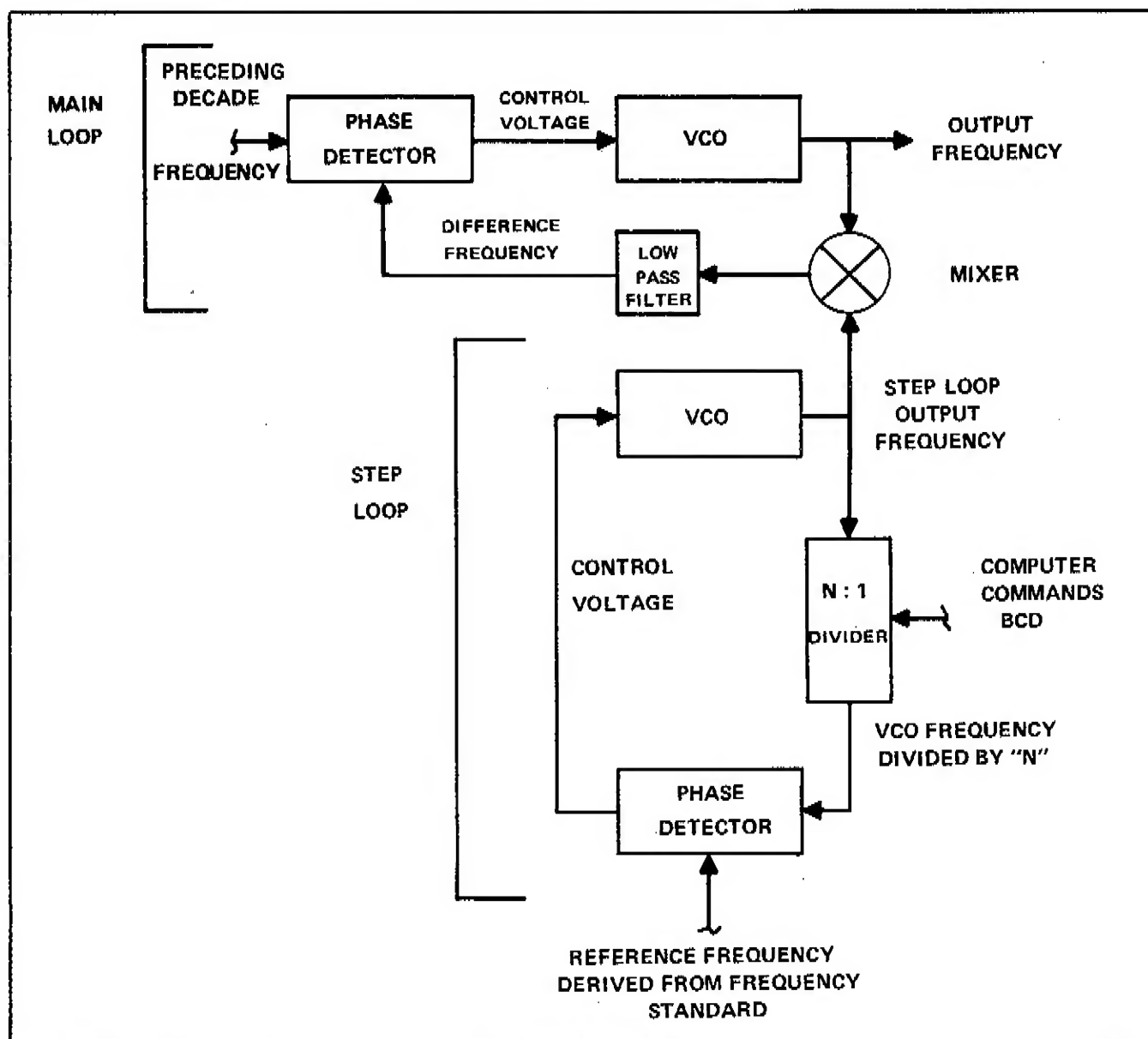


Figure 3-4. PHASE LOCK LOOP ARRANGEMENT

The arrangement consists of Main Loop and Step Loop circuitry. Discrete frequency steps for each digit selected in a decade are produced in the Step Loop. These steps are then added to the preceeding decade frequency in the Main Loop circuit.

3-21. Beginning with the Step Loop, a reference frequency derived from the synthesizer's frequency standard is applied to one input of the phase detector. A divided down Step Loop VCO frequency is applied to the other input. Any difference between the two frequencies results in a dc control voltage output from the Phase Detector. This control voltage is applied to the Step Loop VCO and changes the output frequency until the inputs to the Phase Detector are equal, resulting in a phase lock condition. The Step Loop VCO output frequency is applied to one input of the Main Loop Mixer where it is mixed with the Main Loop VCO frequency. The Mixer output is applied to the Low Pass Filter which yields the difference frequency. A control voltage from the Main Loop Phase Detector changes the VCO frequency until the difference frequency equals the preceeding decade frequency. This results in a Main Loop VCO output frequency which is equal to the Step Loop VCO frequency plus the preceeding decade frequency.

3-22. Varying the frequency steps in a decade is accomplished by varying the division ratio of the N:1 Divider. The N:1 Divider is a programmable counter. It can be preset by BCD commands from the Computer. How much the Step Loop VCO frequency is divided depends upon how many counts are required from any given preset count to the end of the count cycle.

3-23. SIX DIGIT GENERATOR (6040A-4102). Refer to the Block Diagram (drawing 6160B-1501) at the rear of the manual. The Six Digit Generator contains three loops that handle two decades of frequency control. The first loop, which is basically a step loop, controls the 1 Hz and 10 Hz decades. Here, the N:1 Divider has division ratios from 1100 to 1001. With zeros applied from the Computer to the 1 Hz and 10 Hz BCD control lines of the divider, a division ratio of 1100:1 is achieved. Consequently, with nines applied the ratio is 1001. To determine the frequency of the VCO, multiply the known division ratio by the reference frequency. For example, if zeros are applied, the ratio is 1100 which when multiplied by the 25 kHz reference equals 27.5 MHz.

3-24. In the 100 Hz and 1 kHz loop, the frequency steps are generated by a Step Loop and added to the preceeding 1 Hz and 10 Hz frequency in the Main Loop. The

N:1 Divider ratio is from 489, for zeros, and 390, for nines. The 10 kHz and 100 kHz circuit is similar in construction but with an N:1 Divider ratio of 205 to 309:1. This time with zeros programmed, the division is 205:1 and with nines programmed, 304:1.

3-25. 1 MHz DIGIT GENERATOR (6160B-4153). Since the 1 MHz Digit Generator must add its frequency steps to the preceeding Six Digit Generator, it contains a Main Loop and Step Loop. The loops, however, are divided into three modules. The Step Loop is the 6160B-4153-1, Main Loop VCO is 6160B-4153-2, and the Main Loop Phase Detector is 6160B-4153-3. A 1 MHz reference frequency is used in the Step Loop which has a VCO range from 18-37 MHz. Consequently, the N:1 Divider has division ratios of 18-37:1 in 20 steps. With the divider programmed for zero, the ratio is 18:1.

3-26. 10 MHz DIGIT SECTION. The 10 MHz Digit Section consists of five separate modules which together form the step and main loops shown in Figure 3-5. The output ranges from 80 to 159.999999 MHz. The step loop consists of modules titled 10 MHz Step Loop Phase Detector (6160A-4106-1) and 10 MHz D.U. Step Loop VCO (6160A-4107-1). The main loop consists of the 10 MHz D. U. IF Mixer (6160A-4108), 10 MHz D. U. Phase Detector (6160A-4109), and 10 MHz D. U. Main VCO (6160A-4110).

3-27. The 10 MHz step loop modules produce a 70 to 140 MHz output in 10 MHz increments (see table in Figure 3-4). The circuitry associated with the 10 MHz step loop consists of a D/A converter, VCO, and a phase detector. The D/A converter receives the 10 MHz decade internal frequency control commands and produces a dc control voltage which presteers the VCO near to the desired frequency. The resulting VCO signal is then phase locked to a 10 MHz reference using a phase detector.

3-28. The 10 MHz main loop combines the 10 MHz step loop signal and the previous decade information to produce an 80 to 159.999999 MHz output. This signal is produced using a D/A converter and VCO in the 10 MHz D. U. Main VCO module, a subtractive mixer and LPF in the 10 MHz D. U. IF Mixer module, and a phase detector in the 10 MHz D. U. Phase Detector module.

3-29. The D/A converter receives the 10 MHz decade internal frequency control commands and produces a dc control voltage which presteers the VCO to nearly the desired frequency. Nominal overall range of the VCO is from 80 to 160 MHz in 10 MHz range increments. The VCO output is applied to a subtractive mixer and the Output Divider

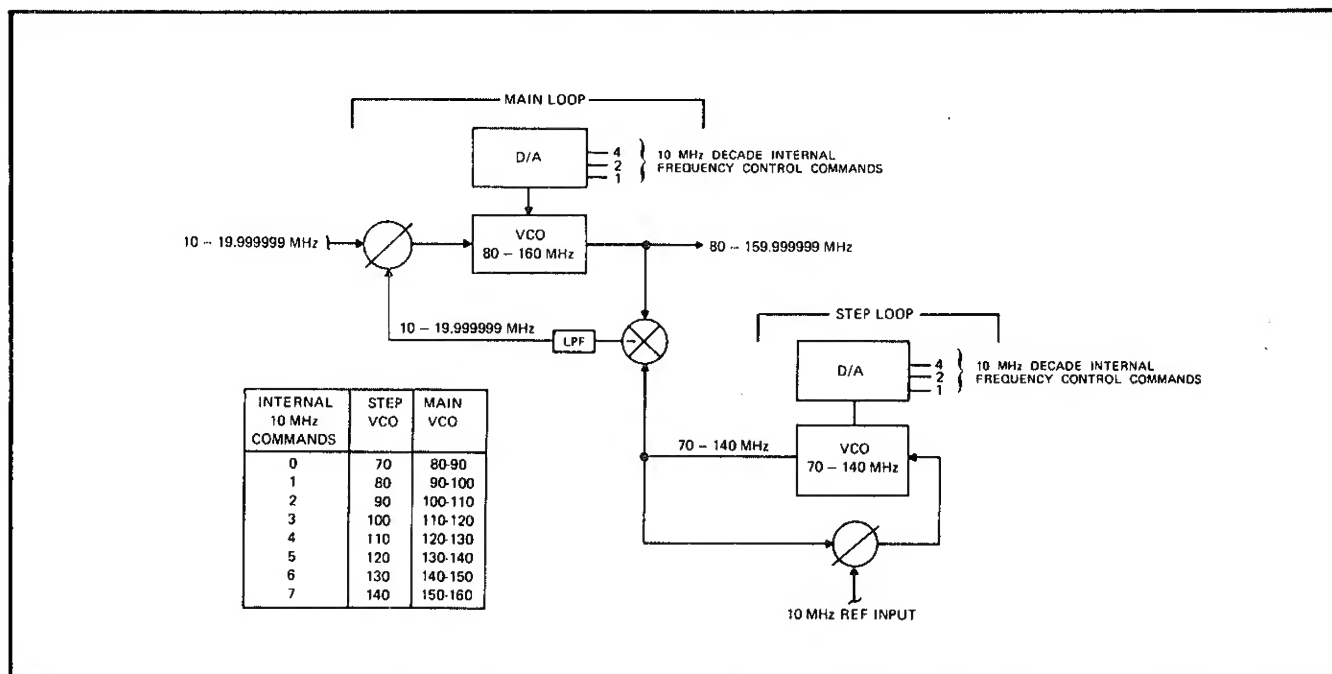


Figure 3-5. 10 MHz DIGIT SECTION

module. The 10 MHz step loop signal of 70 to 140 MHz functions as the other input to the subtractive mixer. Since the main loop signal is 10 to 20 MHz above the step loop signal, the output of the mixer will be approximately 10 - 20 MHz. The resulting output of the mixer is filtered in the LPF and applied to the phase detector. The phase detector compares the mixer output to the output of the 1 MHz Digit Unit Section and supplies a dc control voltage to the main loop VCO that phase locks the main loop such that both inputs to the phase detector are equal in frequency. The resulting 80 to 159.999999 MHz output from the VCO thus contains the entire digit information.

3-30. OUTPUT DIVIDER. The Output Divider (6160A-4111) receives the synthesized frequency of 80 to 159.999999 MHz and produces the final 1 to 159.999999 MHz output. The circuitry consists of an input buffer, six 2/1 dividers, a 5/1 divider, low-pass filters, gates and an output amplifier.

3-31. The 80 to 159.999999 MHz signal is amplified in the input buffer and applied to a gate, low-pass filter, and a 2/1 divider. The 2/1 divider and each successive divider then provides divided down signals to associated low-pass filters. Activation of the appropriate gate by the range and band commands from the frequency control computer then applies the desired low-pass filter output to the output amplifier. This synthesized signal corresponds to the pre-selected output. For example, if a 13.111111 MHz output is selected, the 10 - 160 MHz range and 10 - 20 MHz band

commands activates the gates for the 20 MHz low-pass filter. Since the synthesized input to the Output Divider would be 104.888888 MHz, it is divided by three 2/1 dividers to obtain the preselected 13.111111 MHz output. The output amplifier then produces a +3 to +13 dbm output signal dependent upon the position of the OUTPUT LEVEL control or an external dc amplitude control voltage.

3-32. POWER SUPPLY. The Power Supply (6160A-4014) produces dc operating voltages of +5, +14, and -12V. It receives ac power through the Mother Board (6160A-4013) from the Power Transformer (6160A-4116). A dual winding in the primary of the power transformer allows operation from either a 115 or 230V ac line. The three operating voltages are regulated by individual series-pass regulators. The series-pass transistors are mounted on the Heat Sink (6160A-4021) located on the rear panel.

3-33. CIRCUIT DESCRIPTIONS

3-34. The following paragraphs describe in detail the circuitry in the synthesizer. Associated schematic diagrams are located at the rear of the manual.

3-35. Front Panel PCB Assembly (6160A-4051)

3-36. The Front Panel PCB assembly (Drawing No. 6160A-1051) provides a means to energize the synthesizer as well as converting manual frequency commands to BCD information that are processed by the Computer Assembly

(6160B-4012). It also provides visual indication of operating conditions through light emitting diodes (LED's) labeled POWER and INVALID FREQ. Frequency Dials provide in-line decimal indication of the manually selected frequency. A FUNCTION switch allows selection of two frequency ranges (1 - 12 MHz and 10 - 160 MHz) and the remote mode of operation. Decimal indicators (LED's) are illuminated in the appropriate range such that the manually selected frequency is displayed in MHz. An OUTPUT LEVEL controls allows setting of the RF OUTPUT level anywhere between +3 and +13 dbm.

3-37. Energizing of the synthesizer is done using the FUNCTION switch S9. When S9 is set to a position other than OFF, a ground, via S9C, is applied to terminals 14 and 21 of J1. These grounds enable the Power Supply (Drawing No. 6160A-1014) via the Computer and Mother Board (Drawing Nos. 6160A-1012 and 1013), which then produces +5V, +14V, and -12V operating voltages. Presence of the +5V operating voltage at terminals 32 and 34 of J2 illuminates POWER indicator CR4 via R10. This +5V also illuminates decimal indicator CR1 or CR2 via S9A when it is set to the corresponding 10 - 160 MHz or 1 - 12 MHz position. When the FUNCTION switch is set to OFF, a ground is made available, via S9C, to terminal 13 of J1 which enables the internal Frequency Standard (-01 or -02 Option).

3-38. Selection of the 1 - 12 MHz or 10 - 160 MHz range provides a ground, via S9B, to the rotors of Frequency Dials S1 through S8. These switches produce BCD commands (0V = true) to J1 and J2 which are processed by the Computer assembly to establish the manually selected output frequency. Diodes CR2 through CR33 provide isolation when the REMOTE mode is selected. Selection of the REMOTE mode opens the ground to the rotors of S1 through S8, via S9B, and also opens the ground to terminal 21 of J2. Subsequently, the Frequency Dials are disabled in the REMOTE mode. Absence of the ground at terminal 21 of J2 and presence of +5V at terminals 31 and 33, via S9A, then causes the Computer assembly to process only inputs from the remote input connector at the rear panel.

3-39. The INVALID FREQ. indicator CR3 is illuminated whenever the 1 - 12 MHz range is selected and the 10 MHz Frequency Dial is set to 12 and above. NOR gate U1 receives the 8 and 4 bit commands from S8 at its pins 1 and 2 and ground via S9B when the 1 - 12 MHz range is selected. Presence of all three grounds produces a 0V output at pins 6 and 8 of U1. This 0V output provides a return to ground for CR3 via R1 and R2 and illuminates the INVALID FREQ indicator.

3-40. Control of the output signal level is done using the RF LEVEL control R7. Variable resistor R7 together with R3, R4, R6, and R8 form a divider between ground and +5V. The wiper voltage of R7 is made available to P1 and the Output Divider module (6160A-4111) via an INT/EXT slide switch on the rear panel. Variable resistors R4 and R6 allow adjustment of the upper and lower voltage limits of R7.

3-41. Power Supply (6160A-4014)

3-42. The Power Supply (Drawing No. 6160A-1014) consists of three low-ripple supplies which provide operating voltages of +5V, +14V, and -12V for the synthesizer. A block diagram of the circuitry is shown in Figure 3-6.

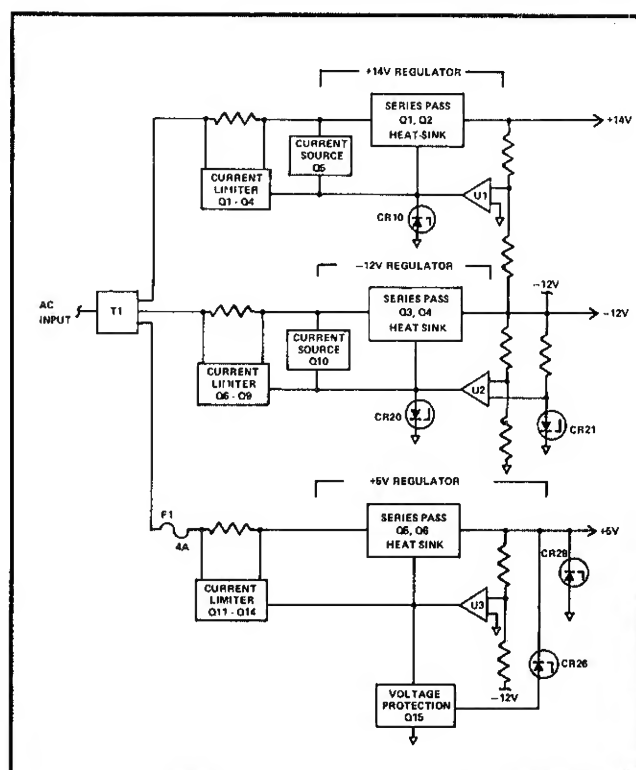


Figure 3-6. POWER SUPPLY BLOCK DIAGRAM

3-43. Input power transformer T1 receives ac line power through the RFI filter, fuses F1 and F2, and slide switch S1. The primary windings of T1 are connected in parallel via S1 for 115V line operation or in series for 230V line operation. Three separate secondary windings of T1 supply full-wave rectifiers CR1 through CR6 and C1 through C3 with required ac operating voltages. The resulting rectified dc voltages are applied to P1 and P2 of the power supply. The dc voltage at pin L of P1 (+24V) is applied to the +14V regulator. It also functions as an unregulated supply voltage for the optional Frequency Standard (6160A-4018). The

dc voltage at pin 4 of P2 (-24V) is applied to the -12V regulator. The dc voltage at pins 9 and 10 of P2 ($+10\text{V}$) is applied to the $+5\text{V}$ regulator.

3-44. The $+14\text{V}$ supply consisting of Q1 through Q5, U1, and series pass elements mounted on the heat sink produces a low-ripple $+14\text{V}$ dc operating voltage for the synthesizer. It also contains a current limiter which prevents overloads from harming the supply. The regulator is enabled by a ground applied to R8 via the FUNCTION switch on the front panel. It consists of constant current source Q5, comparator amplifier U1, and series pass elements Q1 and Q2. Constant current source Q5 provides operating current for the series pass elements Q1 and Q2 and the comparator amplifier U1. One input to U1 is referenced to supply common via R15. The other input to U1 is derived from divider R17 through R21 connected between the $+14\text{V}$ and -12V outputs. Subsequently, the $+14\text{V}$ regulator is referenced to the -12V regulator. Any variations in the $+14\text{V}$ output are sensed at the junction of R18 and R19 by U1, amplified, and alter the conduction of the series pass transistors Q1 and Q2 to maintain the $+14\text{V}$ output. Variable resistor R21 allows adjustment of the $+14\text{V}$ output. Drive voltage input to Q2 is prevented from exceeding $+18\text{V}$ by CR10 in the event U1 and associated circuitry fails.

3-45. Current overloads are prevented from harming the $+14\text{V}$ regulator by Q1 through Q4. Transistor Q1 together with temperature compensator Q2 monitor the voltage drop across R4. When the current through R1 exceeds approximately 1.2A , current through Q1 and resistors R1, R2 in its collector produces a turn-on voltage for Q4. Conduction of Q4 prevents any further increase in base current for series pass driver Q2. The resulting current via series pass element Q1 is subsequently limited at 1.2A . If the regulator output falls below $+14\text{V}$ during a current limit condition, transistor Q3 conducts and further decreases drive current to series pass driver Q2, thus providing "fold-back" current limiting of the regulator output. An example of "fold-back" limiting is shown in Figure 3-7.

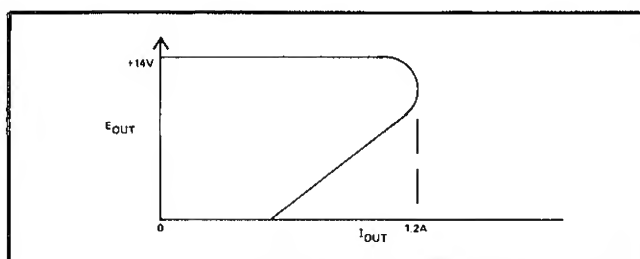


Figure 3-7. "FOLD-BACK" CURRENT LIMITING

3-46. The -12V supply produces a low-ripple -12V dc operating voltage. The supply is enabled by a ground applied

3-8

to R29 via the FUNCTION switch on the front panel. The regulator consists of Q10, U2, CR21, and series pass elements Q3 and Q4. Current limit protection is provided by Q6 through Q9. Operation of this circuitry is very similar to the $+14\text{V}$ regulator. Differences are the use of zener CR21 as a reference for U2 and a current limiting point of approximately 1.1A . Variable resistor R40 allows adjustment of the -12V output.

3-47. The $+5\text{V}$ supply consists of Q11 through Q15, U3, and series pass elements Q5 and Q6. It produces a low-ripple $+5\text{V}$ dc operating voltage. The regulator consists of Q15, U3, and series pass elements Q5 and Q6. Current limit protection is provided by Q11 through Q14. The regulator is referenced to the -12V supply via divider R58 through R61. Enabling is done in sequence with the -12V supply. Operation is very similar to the $+14\text{V}$ supply. Differences are a current limit point of approximately 3.5A and over voltage protection provided by CR26, Q15, and CR28. Fuse F1 provides additional protection at 4A .

3-48. 5 MHz Frequency Standard (6160A-4018)

3-49. The 5 MHz Frequency Standard (Drawing No. 6160A-1018) is installed as the -02 Option. It provides a 5 MHz reference drive source for the synthesizer via a STD OUT connector on the rear panel.

3-50. The frequency standard receives operating voltage from the Mother Board (Drawing No. 6160A-1013) whenever ac power is applied to the synthesizer. When the FUNCTION switch is set to OFF, a ground is applied to pin 8 of the frequency standard. This ground causes Q1 to conduct and apply the unregulated $+14\text{V}$ input at pins H and 7 to terminal 3 of oscillator, Y1. Since the power supply is not operating, the regulated inputs to pins 1 and 6 are not present and terminal 1 of Y1 is at ground via CR2. The unregulated input between terminals 3 and 1 of Y1 then serve as an operating voltage for the oscillator. When the FUNCTION switch is set to a position other than OFF, the ground to pin 8 is removed. Since the power supply is now operating, regulated inputs of $+14\text{V}$ and -12V are applied to pins 6 and 1, respectively. Removal of the ground at pin 8 causes Q1 to cut-off, thus making the applied regulated inputs between terminals 3 and 1 ($+26\text{V}$) of Y1 serve as an operating voltage for the oscillator. Diode CR2 is cut-off because of the -12V input to pin 1. Decoupling of the -12V and $+14\text{V}$ inputs is provided via L1, C1 and L2, C2, respectively.

3-51. Input Filter Module (6160A-4101)

3-52. The Input Filter Module (Drawing No. 6160A-1001) processes the 5 MHz synthesizer drive input and

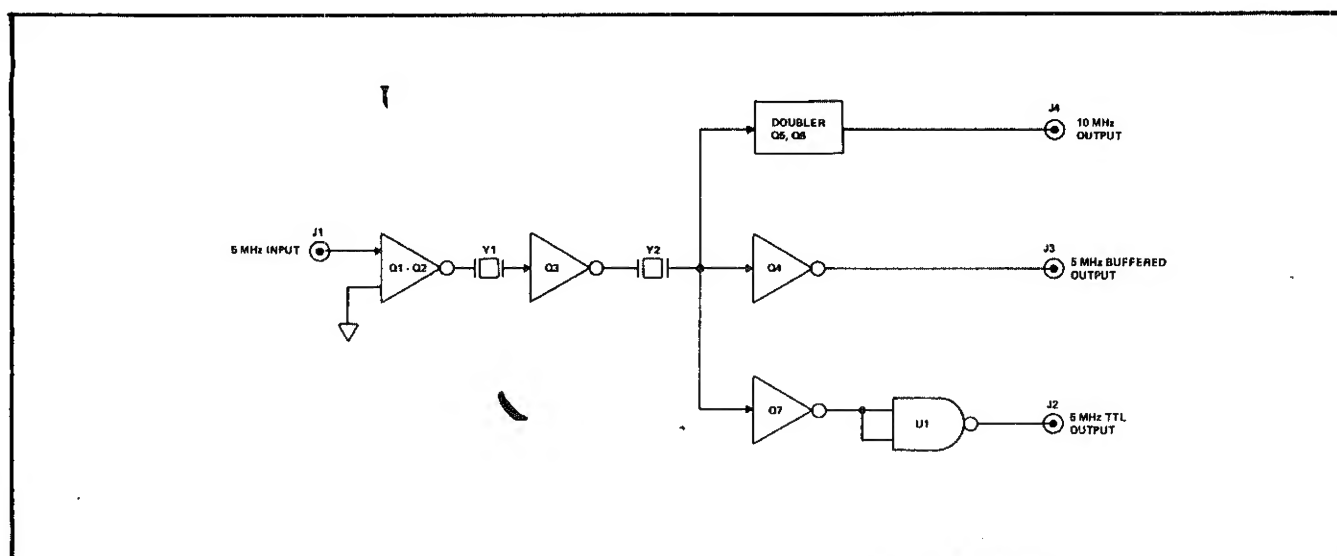


Figure 3-8. INPUT FILTER MODULE BLOCK DIAGRAM

produces two 5 MHz outputs and a 10 MHz output. One of the 5 MHz signals is made available at the rear panel. The other 5 MHz signal and the 10 MHz signal function as internal references within the synthesizer. A block diagram of the circuitry is shown in Figure 3-8.

3-53. The 5 MHz drive input applied to J1 is first processed by the tuned limiter amplifier Q1 and Q2. This circuit functions as a limiter for high level inputs and as an amplifier for low-level inputs. Input signal level requirement is nominally 1V rms \pm 3 db. The resulting signal at L2 is then filtered by Y1, amplified by driver Q3, and further filtered by Y2. The filtered 5 MHz signal is amplified by Q4 to provide a 1V rms into 50 ohm output at J3. Variable resistor R17 allows adjustment of the signal level at J3. Driver Q7 and NAND gate U1 provide a 5 MHz TTL signal at J2. A 10 MHz signal is provided at J4 by the tuned push-pull amplifier consisting of T3, Q5, Q6 and L4.

3-54. Six Digit Generator (6040A-4102)

3-55. 10 HZ STEP LOOP. The 1 Hz and 10 Hz Step Loop can be found on Drawing 6040A-1002, sheet 1. The 50 kHz reference is applied to the 2:1 Divider, U51-12, where it is reduced to a 25 kHz reference signal. This reference is applied to Phase Detector U50-1 where it is compared with the output of the N:1 Divider at U50-3. Output of the Phase Detector is at U50-13 and -2. When the VCO lags the reference signal, an output occurs at U50-13 to the Up Charge Pump. The Up Charge Pump, Q37 and Q36, charges C111 with pulses of current which causes a corresponding voltage rise. The rising

voltage is coupled through the low-pass filter C109, C108, L29, C107, C106 and L28 to the varactor diode CR12. The voltage rise causes CR12 to change its capacitance causing an increase in VCO frequency. When the VCO frequency leads the reference signal, the Phase Detector output is at U50-2. In this situation the Down Charge Pump, Q25, conducts and discharges C111 which in turn causes a lowering of the control voltage to the VCO. This results in a decrease in VCO output frequency. The VCO ranges in frequency from 27.5 to 25.025 MHz and consists of CR12, T5, and Q27, with Q26 acting as a buffer to reduce loading. Limiter Amplifiers Q34 and Q35 tend to square the sinusoidal output of the VCO. The squared output is applied to buffer amplifier U44-12, U44-6, and U47-6 to obtain sufficient TTL drive for the N:1 Divider. Another path for the VCO output is through U44-12 and U44-8 to through the 10:1 Divider U42. The output at U42-12 is applied to the 100 Hz and 1 kHz Main Loop where it will be added to the 100 Hz and 1 kHz step loop frequency.

3-56. The N:1 Divider consists of two programmable ten-state counters (U45 and U46), a sixteen-state counter (U49), an AND input flip-flop, and gates U47-8 and U47-12. In this arrangement the 1 Hz and 10 Hz BCD control lines are connected to the ten-state counters U45 and U46, respectively. The buffered TTL output of the VCO is applied to the clock 1 input of U45-8. The number of counts required to get an output from the N:1 divider depends upon what state the counters, U45 and U46, are preset to by the 1 Hz and 10 Hz control inputs. With zeros programmed into the counters it takes 1100 counts

for an output from the N:1. Programming for nines results in a much lower count of 1001. The end of a counting cycle occurs on the second clock pulse to U48-12 after U47-8, 48-9, -10, -11, and -12 are high. This results in U48-6 going high which is buffered through U47-12 to the Phase Detector, U50-3. The low output from U48-8 initiates the load inputs of U45 and U46. This causes any data appearing on the 1 and 10 Hz control lines to be loaded.

3-57. 100 HZ AND 1 KHZ STEP LOOP. This step loop can be found on schematic drawing number 6040A-1002, sheet 2. The circuit arrangement is quite similar to 1 Hz and 10 Hz Step Loop. Here, a 100 kHz reference frequency is divided by two at U39 to provide a 50 kHz reference signal. This reference is applied to Phase Detector U38-1 which compares it with the N:1 Divider output to U38-3. The outputs of the Phase Detector, U38-13 and -1, are applied to Up and Down Charge Pumps (Up - Q31 and Down - Q24). The resulting voltage from the charging and discharging of C112 is filtered by C81, C80, L21, C79, C78, and L20 and applied to varactor diode CR10 in the VCO to achieve a phase lock condition. Part of the filtered control voltage to the VCO is coupled through rc filter R110 and C82 to a voltage follower, U37. The output from U37 is a feedback voltage to provide more or less current for the Up Pump. It also provides a control voltage to a pair of diode voltage clamps, CR8 and CR89 in the Main Loop VCO control voltage circuit. The reason for this is discussed in the 100 Hz and 1 kHz Main Loop description. The VCO is almost identical to the previously discussed 10 Hz Step Loop VCO except that its output frequency is 24.45 to 19.5 MHz. The output is applied through buffer gates U30-12, U30-6, U31-11, and U31-3 to provide sufficient TTL drive for the N:1 Divider. A part of the VCO output is buffered by U30-12 and U30-8 for application to the Main Loop Mixer.

3-58. The buffered VCO output frequency is applied to the N:1 Divider input at U32-8. The number of counts required to achieve an output from the divider at U36-14 depends upon the preset states of U32 and U34. Preset data comes from the 100 Hz and 1 kHz Input lines from the Computer. With U32 and U34 programmed to zero a full count of 480 is required to get an output pulse from the N:1 Divider at U36-14. When U36-15 goes low as a result of this, data present on the 100 Hz and 1 kHz Input lines are loaded into U32 and U34.

3-10

3-59. 100 HZ AND 1 KHZ MAIN LOOP. One input to the Main Loop is from the 1 Hz and 10 Hz Step Loop and ranges from 2.75 to 2.5025 MHz. This input is first applied to a 5:1 Divider, U29, resulting in an output frequency of .55 to .505 MHz. The output of the 5:1 Divider is applied to one input of the Phase Detector, U28-1. The other input to the Main Loop is from the 100 Hz and 1 kHz Step Loop and ranges from 24.45 to 19.5 MHz. This input signal is applied through C51 to U26-11, the Frequency Mixer. The other input to the mixer is the buffered Main Loop VCO frequency ranging from .25 to 20 MHz. These inputs to U26 are mixed and the resulting difference frequency, .55 to .5 MHz, is filtered through C59, C60, and L27 to amplifier Q20. Transistor amplifier Q20 operates in a saturated mode and provides a TTL level square wave output from its linear input. The TTL signal at .55 to .5 MHz is applied to the other input of the Phase Detector, U28-3. The bistable outputs of the Phase Detector, U28-13 and -2, are coupled to the Charge Pumps. The resulting control voltage alters the VCO frequency to achieve a phase lock. Output frequency from the VCO is applied through buffer drivers to the Mixer. Another output path is through buffer gate U25-8 to a 10:1 Divider, U24. The 2.5 to 2 MHz output from the divider, U24-12, is applied to the input of the 10 kHz and 100 kHz Main Loop.

3-60. The control voltage created by the Charge Pumps in conjunction with charge capacitor C71 is contained within a predetermined voltage "window". The window limits are determined by voltage clamps CR8 and CR9. These clamps are controlled by a control voltage from the Step Loop voltage follower U37. This control voltage is derived from the Step Loop VCO control voltage. The purpose of this control is to pull the Main Loop VCO along with the Step Loop VCO when large frequency changes are required. This keeps the Main Loop within a close range to achieve a rapid phase lock. In addition, Main and Step Loop VCO's track very closely. This occurs because the varactor diodes, CR9 of the Main Loop and CR10 of the Step Loop are matched.

3-61. 10 KHZ AND 100 KHZ STEP LOOP. This Step Loop schematic diagram can be found on drawing 6040A-1002, sheet 4. A 1 MHz reference signal from J1 is applied to buffer gates U16-11 and U16-8 for application to the

10:1 Divider U15. Part of the 1 MHz signal goes through U16-3 and U16-6 to J3 which is applied to the Computer as the clock signal. The 100 kHz references out of the 10:1 Divider U36-11 is applied to one input of the Phase Detector U14-1. The other input to the Phase Detector is from the N:1 Divider. Outputs from the Phase Detector, U14-13 and -2 are applied to the Charge Pumps which in conjunction with the charge capacitor C17 provides the VCO control voltage. This voltage is filtered and applied to the VCO to achieve a phase lock condition. Part of the VCO control voltage is fed back through voltage follower U13 to the Main Loop VCO control voltage clamps. The U13 output is also buffered by Q7 and applied to the Up Pump to supply the necessary current. The VCO ranges from 20.5 to 30.4 MHz and functions like the VCO's previously described. Its output is buffered to the N:1 divider and to the Main Loop Mixer.

3-62. Input to the N:1 Divider is at U6-8. The pre-settable counters are U6 and U8. Data on the 10 kHz and 100 kHz control lines are applied to nines complement circuits U2, U4 and U7. The nines complement of the control line data presets the counters. When the Control Input lines are at zero the nines complement circuits load nines into the counters U6 and U8. Therefore, fewer counts are required for an output so that the input will be divided by 205. When the Computer commands to the 10 KHz and 100 kHz Control Inputs are nines, the N:1 will divide by 304.

3-63. 10 KHZ AND 100 KHZ MAIN LOOP. One input to the Main Loop (drawing 6040A-1002, sheet 5) is from the 100 Hz and 1 kHz Main Loop. This input varies from 2.5 to 2 MHz and is applied through a 5:1 Divider, U32, to one input of the Phase Detector, U21-3. The other input to the Main Loop is from the Step Loop. This input ranges from 20.5 to 30.4 MHz and is applied to one input of the Frequency Mixer, U19. The other mixer input is from the VCO, which ranges from 20 to 30 MHz, and is applied through U18-12 and U18-8 to U19-5. The difference frequency .5 to .4 MHz, from the mixer is coupled by a low pass filter (C39, C38, L13, C41, and L14) to the linear to TTL amplifier Q14. Output from Q14 is applied to the other input of the Phase Detector, U21-1. Bistable outputs from the Phase Detector go to the Charge Pumps for production of the VCO control voltage to achieve phase lock. The VCO output is buffered through U18 and U17

to achieve sufficient drive at the output, J2, for connection to the 1 MHz Digit Generator section.

3-64. The varactor diodes CR1 and CR2 in the Step and Main Loops are also matched to provide close tracking between the oscillators. Voltage limits are also placed on the VCO control voltage to keep both the Main and Step Loops close together during large step changes. In this main loop, the upper window stop is controlled by operational amplifier U23 and CR3. This circuit insures that no current will be drawn from control signal until the upper stop is reached. The lower window stop is set by CR4 and CR5. Control voltage from the step loop is applied to U23-3 and the anode of CR4.

3-65. 1 MHz Digit Generator

3-66. The 1 MHz Digit Generator Module Set, which consists of a main loop and step loop is divided among three modules. These modules are the 1 MHz Step Loop (6160B-4153-1), 1 MHz Main Loop VCO (6160B-4153-2) and the 1 MHz Main Loop Phase Detector 6160B-4153-3. The input frequency to the module set ranges from 20 to 30 MHz. Increments relating to the 1 MHz decade are added to the incoming frequency and result in an output frequency range from 10 to 20 MHz.

3-67. 1 MHZ STEP LOOP (6160B-4153-1). The Step Loop schematic diagram can be found on drawing number 6160B-1053, sheet 1. A 5 MHz reference signal from the Input Filter is applied through J1 to a 5:1 Divider, U4-6. One of the 1 MHz outputs, U4-2 is applied to one input of the Phase Detector, U5-3. The other output, U4-12, goes to J2 where it is connected to the Six Digit Generator for use as a reference signal. The other input to the Phase Detector, U5-1, comes from the N:1 Divider. Outputs from the Phase Detector, U5-2 and -8, are applied to the Charge Pumps. Transistors Q7 and Q11 comprise the Up Charge Pump while Q8 and Q9 are the Down Charge Pump. A slight leakage current is caused by R27 in the Down Charge Pump circuit so that the Up Charge Pump will be normally on. The current pulses from either pump charge the integrator R20 and C29. Voltage across the integrator is applied to the low pass filter, C26, C22, C23, L8, C24, C19, C29, L6, C21, L4, C16, C11, and L3. The filtered variable dc control voltage biases the cathode of the varactor

diodes CR2 and CR3. A fixed bias for the anode side of CR2 and CR3 is provided by Q10. The effect of the dc control voltage is to alter the VCO frequency so as to achieve phase lock condition in the loop. A portion of the dc control voltage to the VCO is fed to operational amplifier U3 which feeds back a voltage through Q6 and R19 to the Up Charge Pump. This feedback compensates changes in loop gain due to the non-linearity of the varactor tuning diodes and the division ratio changes of the N:1 Divider. The VCO output from the oscillator transistors, Q4 and Q5, is fed to limiter amplifier Q3 and Q2 and Schmitt trigger U1-12 to provide a TTL square wave output. Part of the output is buffered by U1-8 for application to the following 10 MHz Digit Generator. The other part is buffered by U1-6, U2-8, and U7-12 for application to the N:1 Divider.

3-68. The N:1 Divider consists of J-K flip-flops U6 and U8, programmable counter U9, and gates U10-6, U7-6, and U7-8. Control lines from the Computer go through a nines complement circuit (U11 and U10) before pre-setting the counter, U9. Toggle counting is performed by U6-5, U9, and U8-15. Gates U7-6 and U7-8 compare the outputs from the counting devices and detect the end of the counting cycle. At the end of cycle detection, flip-flop U6-9 and U8-11 reset the counter elements and cause new data to be loaded into U9. With a zero binary command from the Computer, the N:1 Divider adjusts to provide an 18:1 division ratio. As the binary commands increase in magnitude the division ratio increases to a maximum of 37:1.

3-69. 1 MHz MAIN LOOP PHASE DETECTOR (6160B-4153-3). The Main Loop Phase Detector schematic diagram can be found on drawing number 6040A-1004. The 20 to 30 MHz signal from the preceeding decade is applied through J3 and 10:1 divider, U2-2, to one of the Phase Detector inputs, U3-1. This 2 to 3 MHz signal is compared with the 2 to 3 MHz intermediate frequency from the Main Loop VCO and mixer module. The IF is applied through J4 to low pass filter C17, C18, C19, and L8. The signal is amplified by Q6 and applied to a Schmitt trigger, U4, to provide a TTL square wave to the other input of the Phase Detector, U3-3. Outputs from the Phase Detector, U3-13 and 8, are applied to the Charge Pumps. The Up Charge Pump consists of Q2 and Q3 and the Down Charge Pump is Q4 and Q5. As in the Step Loop Down Pump, this Down Pump has a resistor, R20, which causes enough

leakage current to keep the Up Pump normally on. The integrator for the current pulses from the pumps is R14 and C10. The resulting control voltage is filtered by low pass filter C11, C12, L6, C13, L7, and C14. Remaining filtering occurs in the Main Loop VCO to J1 module whose input is connected.

3-70. To keep the Main Loop tracking the Step Loop during large step changes, the control voltage is kept within constraints established by a voltage window. The tie point for the voltage limiter circuit is between L6 and L7. The lower window stop is established by CR2 while a more precise upper window stop is established by an operational rectifier, U1 and CR1. Current source Q1 in conjunction with R5 establishes a reference level for U1. A buffered version of the Step Loop control voltage is applied to J2 and labeled V_c . This tracking voltage approximately positions the Main Loop VCO so that the Main Loop can capture the signal and the Phase Detector can lock.

3-71. 1 MHZ MAIN LOOP VCO. The Main Loop VCO schematic diagram can be found on drawing number 6160B-4153, sheet 2. The VCO control voltage from the Phase Detector module is applied through J2 and remaining low pass filter elements to the varactor tuning diodes CR1 and CR2. The control voltage cause the capacitance of the varactor diodes to change, which alters the output frequency of the VCO. With the control voltage biasing one side of the diodes, the other side is fixed biased (V_b) by the same source as in the Step Loop diodes. Diodes in the Main Loop and Step Loop are cross matched so that they will track closely. The output signal from the Main Loop VCO goes through limiter amplifier Q3 and Q4 and Schmitt trigger U2-12. The resulting TTL square wave is buffered by U2-8 and divided by 2:1 in U3 to provide a 10 to 20 MHz output to the following decade. Another output path from U2-12 is buffered by U2-6 and applied to one input of the mixer, U1-5. The 18 to 37 MHz output from the Step Loop is applied to J4 where it is attenuated by R1 and R2 and filtered by C1 through C3 and L1 through L3 before being applied to the mixer, U1-10. Resulting sum and difference frequencies from the mixer are applied to filter C10 through C13 and L4 which passes the difference frequency. This intermediate frequency at J4 is connected to the Main Loop Phase Detector Module where it filtered and amplified for application to the phase detector.

**3-72. 10MHz D.U. Step Loop VCO Module
(6160A-4107-1)**

3-73. The 10MHz D. U. Step Loop VCO Module (Drawing No. 6160A-1007-1) produces a 70 to 140MHz step

loop signal for the 10MHz digit section. This signal is available in 10MHz steps which correspond to 10MHz decade commands of 0 to 7. A block diagram of the circuitry is shown in Figure 3-9.

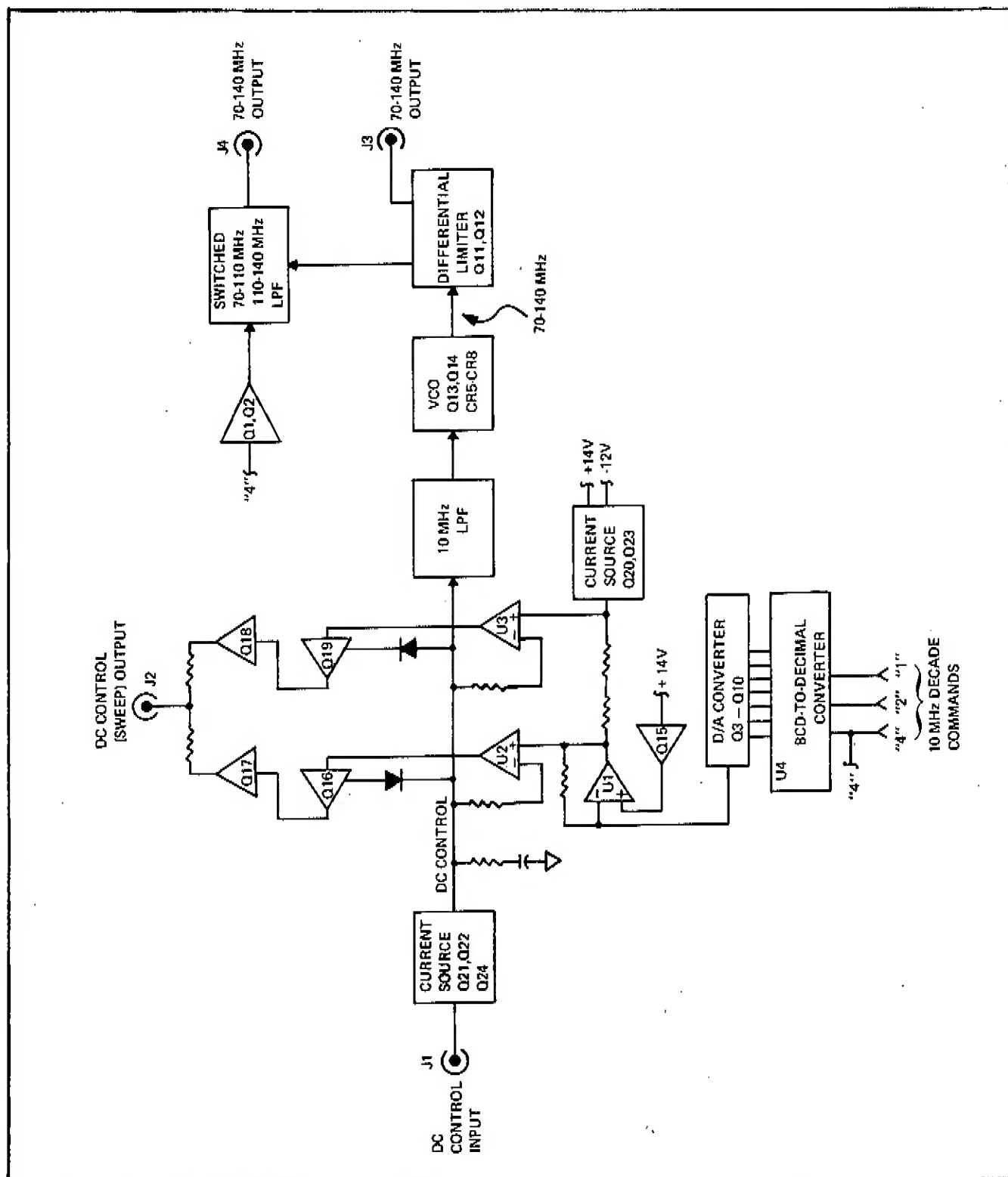


Figure 3-9. 10 MHz D. U. STEP LOOP VCO MODULE BLOCK DIAGRAM (6160A-4107-1)

3-74. The dc control voltage applied to J1 is processed by current sources Q21 and Q22 which produce a dc control across C25 via R57. In a static condition (OV input), the opposing currents supplied through Q21 and Q22 counterbalance each other such that the voltage across C25 is constant. A positive going input at J1 decreases conduction of Q22, thus providing an increase in voltage across C25 via current source Q21. The opposite is true for a negative going input to J1. Transistor Q24 supplies bias current for Q22 in relation to any change in voltage across C25. Variable resistor R60 allows adjustment of the threshold current switching point of Q21 and Q22.

3-75. A 10MHz low-pass filter consisting of C19, C20, C21, C24, L14, and L15 removes any ripple at or above 10MHz in the voltage across C25. This filtered dc control voltage is then applied to a 70 to 140MHz VCO.

3-76. The VCO composed of CR5 through CR8, Q14, and a printed circuit inductor produces a 70 to 140MHz signal dependent upon the dc control voltage across C25. Capacitance value of varicaps CR5 through CR8 depends on the applied control voltage. These varicaps together with the tapped printed circuit board inductor form a tuned circuit. Conduction of Q14 develops a signal that is coupled via C16 to the tuned circuit. Regenerative feedback to the base of Q14 via R30 sustains oscillations at the resonant frequency of the tuned circuit. Transistor Q13 buffers the VCO signal, which is then coupled via T3 and C12 to Q12.

3-77. Transistors Q11 and Q12 form a differential limiter which translates the 70 to 140MHz VCO signal to a squarewave. The output of Q11 is applied to J3 via R18 and T1. The output of Q12 is passed through a switched, low-pass filter consisting of C1 through C4 and L1 through L5. When the VCO frequency is from 70 to 100MHz (10MHz decade commands of 0 through 3), transistor Q1 is switched on by the OV ("4" bit absent) emitter voltage via CR9. Conduction of Q1 turns on Q2 which then turns on diodes CR1 through CR4. Capacitors C1 and C4 are subsequently placed in parallel with C2 and C3 and lower the switched filter cut-off frequency to nominally 110MHz. Presence of a 10MHz decade command of 4 thru 7 (4 bit present) produces a +2V or greater emitter voltage at Q1, thus turning it off. Q2 is also switched off by this condition, and diodes CR1 through CR4 are switched off by the resulting -12V collector voltage of Q2. Capacitors C1 and C4 are subsequently disconnected from the switched filter, increasing its cut-off frequency to nominally 140MHz.

3-78. Presteering the VCO frequency to approximately the correct point is done via U4, Q3, through Q10, and U1

through U3 together with Q16, Q19, and Q20, Q23. The 10MHz commands (4-2-1) are converted to decimal information by U4. This decimal information then controls conduction of Q4 through Q10, which produce proportional decimal weighted voltages at the input to U1. The resulting output of U1 is compared to the dc control voltage applied to the VCO via U2 and U3. If the potential difference is greater than 0.3V, the output of U2 or U3 is then used to force the VCO control voltage to within $\pm 0.3V$ of the correct value by conduction of Q16 or Q19.

3-79. The 10MHz decade commands are converted to decimal information by U4. Presence of a decimal output (OV) from U4 turns off the diode associated with Q4 through Q10 and allows the transistors to provide a proportional decimal weighted voltage at their collectors. Absence of a decimal output (+2 to +5v) from U4 turns on the diode associated with Q4 through Q10, which switches the transistors off. Transistor Q3 together with R8 form a temperature compensated bias supply for Q4 through Q10. Variable resistors in the emitter circuits of Q4 through Q10 allow adjustment of the decimal weighted voltage increments.

3-80. Integrated circuit U1 is a differential, operational amplifier. It compares the decimal weighted output of Q4 through Q10 to a fixed reference established by Q15. Variable resistor R70 allows adjustment of the reference and subsequently the "0" decimal voltage equivalent. The resulting output of U1 produces a voltage across R36 and R42 that is decimal weighted to the 10MHz commands. This voltage is applied to one input of comparator amplifier U2. Transistors Q20 and Q23 produce a reference current through R42 and R36 which establishes a maximum voltage reference input to U3, another comparator amplifier. Since this reference input to U3 is affected by the output of U1, the inputs to U2 and U3 track approximately 0.6V apart, thus establishing a "window" voltage dependent upon the 10MHz commands. An example of the "window" voltage is shown in Figure 3-10.

3-81. Comparator amplifiers U2 and U3 each receive a sample of the dc control voltage at their other input via R35 and R41. Should this input be above or below the other input to U2 or U3, one or the other conducts and switches on transistor Q16 or Q19. Conduction of Q16 or Q19 then provides a rapid charge or discharge current to C25 via CR17 or CR19 that brings the dc control voltage to within 0.6V of its correct value. Transistors Q17 or Q18 are also switched on by conduction of Q26 or Q19 and provide a plus or minus sweep control output at J2. This sweep control voltage causes the input to J1 to rapidly approach its correct value via another circuit in the 6160A-4106-1 module.

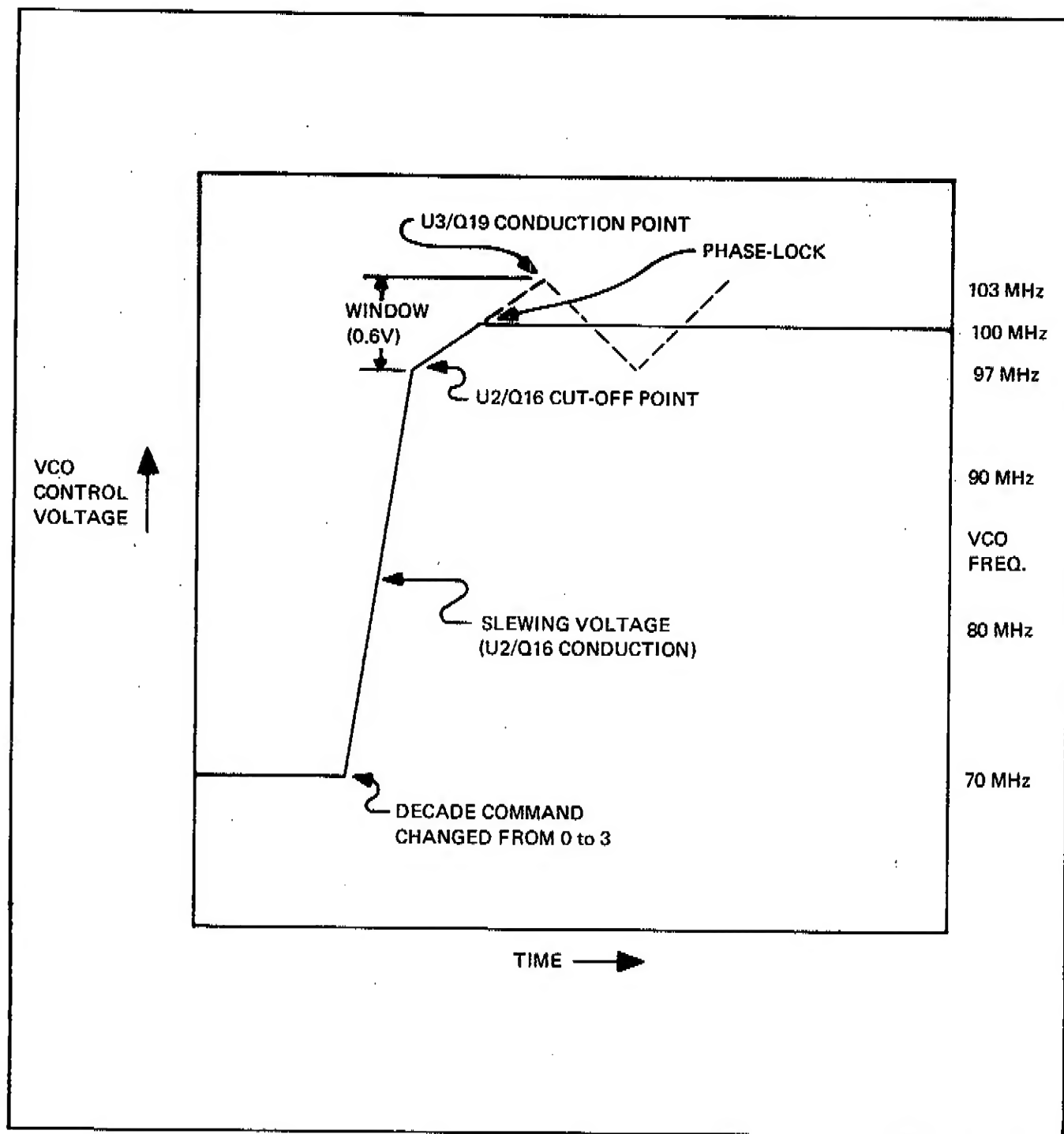


Figure 3-10. VCO "WINDOW" VOLTAGE

3-82. 10MHz D.U. Step Loop P.D. Module (6160A-4106-1)

3-83. The 10MHz D.U. Step Loop P.D. Module (Drawing No. 6160A-1006-1) receives a 10MHz reference signal and a 70 to 140MHz step loop signal and dc sweep voltage from the 10MHz digit section. It compares the two rf sig-

nals and produces a dc control voltage which phase-locks the 10MHz step loop section. The dc sweep voltage (present when the 10MHz step loop is not phase-locked) is processed to provide a rapid change in dc control voltage output necessary to achieve phase-lock. A block diagram of the circuitry is shown in Figure 3-11.

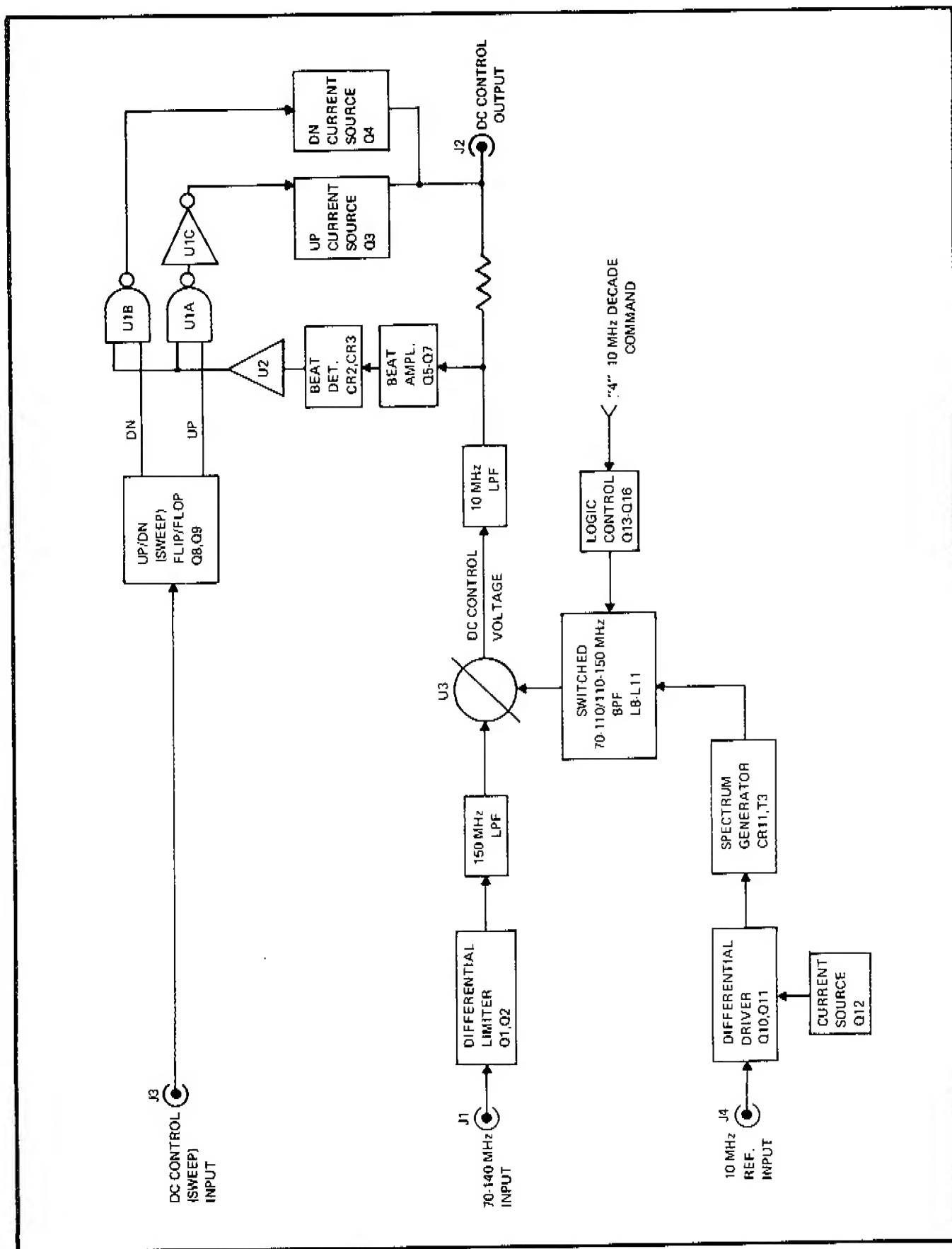


Figure 3-11. 10 MHz D. U. STEP LOOP P. D. MODULE BLOCK DIAGRAM (6160A-4106-1)

3-84. The 10MHz reference input at J4 is amplified by differential driver Q10 and Q11. Transformer T4 sums the outputs of Q10 and Q11 and couples the signal to the following spectrum generator. Transistor Q12 provides a constant current for Q10 and Q11. Variable resistor R27 allows adjustment of this current and subsequently the output drive level of the signal at T4.

3-85. Step-recovery diode CR11 together with T3 form a spectrum generator which produces a series of pulses rich in harmonics of 10MHz. Variable resistor R34 adjusts the bias on CR11. The resulting spectrum signal is tapped at T3 and applied via an impedance matching pad consisting of R39, R40, and R41 to a switched, band-pass filter.

3-86. The switched filter consists of L1, L2, L8 through L11, L20, C31, and C34 through C39. It passes only frequencies between 70 to 110MHz or 110 to 150MHz, depending upon the condition of the "4" 10MHz decade command. Absence of this command (OV), turns off Q13 and Q16 and switches on Q14 and Q15. Conduction of Q15 turns on diodes CR4 through CR7 and places C37, C39 in parallel with C36 and C38. Since Q16 is off, diode CR18 is also off and L11 together with C35 are in series with L20. This condition provides an overall 70 to 110MHz band-pass characteristic for the filter. Presence of the "4" command (+5V), turns on Q13 and Q16 and switches Q14 and Q15 off. Conduction of Q16 turns on CR18 via CR8 and grounds the junction of L20, L11. With Q15 off, diodes CR4 through CR7 are also off, which disconnects C37 and C39. Overall response of the band-pass filter is subsequently 110 to 150MHz in the presence of a "4" bit command. The resulting filtered band-pass signal is then applied directly to one input of phase detector U3.

3-87. The 70 to 140MHz input at J1 is amplified by differential driver Q1 and Q2. The resulting amplified signal is summed in T1 and coupled via a 150MHz low-pass filter composed of L6, L7, and C7 through C12 to one input of U3. Balanced mixer U3 compares the 70 to 140MHz input at pin 1 to the 70 to 100MHz or 110 to 140MHz input at pin 6 and produces a plus or minus output at pin 4 which is proportional to any offset. The 10MHz low-pass filter composed of L12, L21, and C13 through C16 removes any ripple above 10MHz. Variable capacitor C13 allows adjustment of the filter-"notch" response to 10MHz. The resulting filtered signal is applied

via R53 to J2. This signal or dc voltage is then used to control the precise frequency of a VCO in the 6160A-4107-1 Module and phase-lock the 10MHz digit step loop.

3-88. When the 10MHz digit, step loop is out-of-lock, the circuitry consisting of Q3 through Q9, U1, and U2 produces a positive or negative dc output at J2. This output causes the 10MHz digit step loop to approach the correct phase-lock point.

3-89. Presence of a positive or negative dc input to J3 exists when the step loop is grossly un-locked. This input causes flip-flop Q8 and Q9 to provide a positive gate to U1A or U1B, depending on the polarity of the input to J3. If a positive input is present, the output of Q9 is +5V and U1A receives a positive gate. Should the input to J3 be negative, the output of Q8 is +5V and U1B receives a positive gate.

3-90. NAND gates U1A and U1B receive an enable command (+5V) from U2 whenever a beat signal is present at J2. This beat signal exists whenever there is a difference between the two inputs to phase detector U3. AC amplifiers Q5 through Q7 amplify the beat signal, which is then peak detected by CR2 and CR3. The resulting positive voltage across C21 is converted to a +5V enable command by U2 and applied to NAND gates U1A and U1B.

3-91. When both inputs to U1A or U1B are high (positive), the low output switches on up or down current sources Q3 and Q4 and produces a positive or negative dc output at J2. Current source Q3 is switched on via inverter U1C when both inputs to U1A are positive (up sweep) and produces a positive voltage at J2. A negative voltage at J2 is provided via Q4 which is switched on by U1B (down sweep).

3-92. 10 MHz D. U. IF Mixer Module (6160A-4108)

3-93. The 10 MHz D. U. IF Mixer Module (Drawing No. 6160A-1008) combines the 80 to 160 MHz main loop and 70 to 140 MHz steploop signals of the 10 MHz digit section. The resulting 10 to 20 MHz difference is then used to phase-lock the main loop in the 10 MHz digit section. A block diagram of the circuitry is shown in Figure 3-12.

3-94. The 70 to 140 MHz step loop input to J2 is amplified by tuned driver Q3. The signal at tapped indicator T2 is coupled by C15 to a 140 MHz low-pass filter consisting of L5 through L9, C16, and C17. This filter removes any ripple above 140 MHz and applies the signal to pin 6 of mixer U1 where it functions as a linear input. An 80 to 160 MHz main loop input to J1 is translated to a symmetrical squarewave by tuned differential limiter Q1 and Q2. Positive going inputs to Q1 cause it to conduct the maximum current available through R1 and R2. Transistor Q2 is cut-off during this period and no signal is developed in its collector. When the input to Q1 goes negative, it is cut-off and Q2 conducts the maximum current available through R1 and R2. The resulting 80 to 160 MHz squarewave at T1 is filtered by C6 through C10, L1, and L2 to remove any ripple above 160 MHz. Capacitor C42 couples the filtered

signal to pin 1 of mixer U1 where it functions as a switching input.

3-95. Mixer U1 combines the 70 to 140 MHz step loop and 80 to 160 MHz main loop signals. A 20 MHz low-pass filter consisting of C18 through C21, C26 through C28, and L14 through L16 selects the 10 to 20 MHz difference frequency. Driver Q4 amplifies the 10 to 20 MHz resultant which is then applied to Q5. FET Q6 functions as a vari-automatic amplitude control of the output signal from the emitter and collector of Q5. The collector signal of Q5 is applied to J4, via tapped inductor T3, while its emitter signal is applied to Q7 via R25 and C35. Driver Q7 amplifies the emitter output of Q5 which is then applied to buffer Q10 and amplitude detector CR1, CR2. Buffer Q10 produces a variable load at the output of Q4. This variable load provides

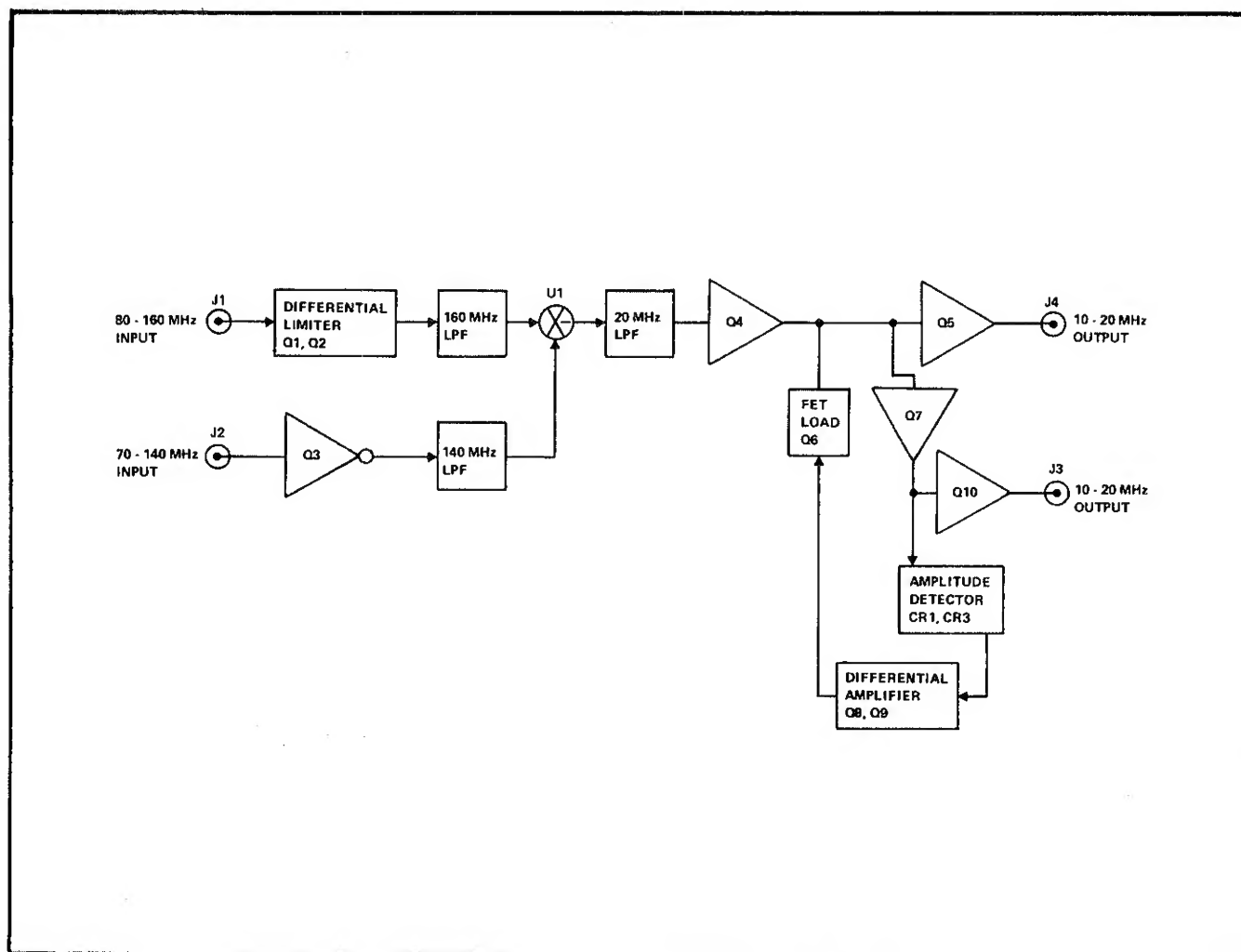


Figure 3-12. 10 MHz D. U. IF MIXER MODULE BLOCK DIAGRAM

10 to 20 MHz output that is isolated from the amplitude detector to J3. Diodes CR1 and CR2 detect the amplitude of the collector signal from Q7 and provide a proportional dc input to Q8. Transistors Q8 and Q9 form a differential amplifier which amplifies any difference between the reference voltage set by R35 and the dc input from the amplitude detector. The difference output from Q9 drives FET Q6. Subsequently, the amplitude of the outputs at J3 and J4 are automatically controlled.

3-96. 10 MHz D. U. Main P. D. Module (6160A-4109)

3-97. The 10 MHz D. U. Main P. D. Module (Drawing No. 6160A-1009) combines the 10 to 20 MHz output from the 1 MHz digit section with 10 to 20 MHz signals from the 10 MHz main loop. The resultant dc output then determines the frequency and phase of the 10 MHz main loop. A block diagram of the circuitry is shown in Figure 3-13.

3-98. The 10 to 20 MHz input from the 1 MHz digit section at J4 is translated to a symmetrical squarewave by differential limiter Q1 and Q2. Negative going inputs to Q1

cause it to conduct the maximum available current through R1. Transistor Q2 is cut-off during this period and no signal is developed in its collector. When the input to Q1 goes positive, it is cut-off and Q2 conducts the maximum current available through R1. The resulting 10 to 20 MHz square-wave at T1 is then coupled, via C7, to phase detector U1, where it functions as a switching input. Phase detector U1 receives a linear 10 to 20 MHz input from J3. This input is derived from the 10 MHz main loop. A low-pass filter consisting of C18 through C20 and L7 removes any ripple above 20 MHz.

3-99. Phase detector U1 combines the two 10 to 20 MHz inputs and produces an output that is the difference frequency. If both inputs are equal in frequency, the output is a dc voltage proportional to the cosine of the phase relationship between the two inputs. A low-pass filter consisting of C21, C22, C24, L8, and L9 removes any ripple above 7 MHz. The resulting difference frequency or dc voltage is applied, via R50, to J2. Presence of a dc voltage output from U1 (main loop phase-locked) causes FET gate Q19 to conduct which grounds the junction of R49 and R51. However, when the output of U1 exceeds 1 MHz, Q19 is cut-off and a dc voltage derived from the output of U2 is applied, via R49 and R51, to J2.

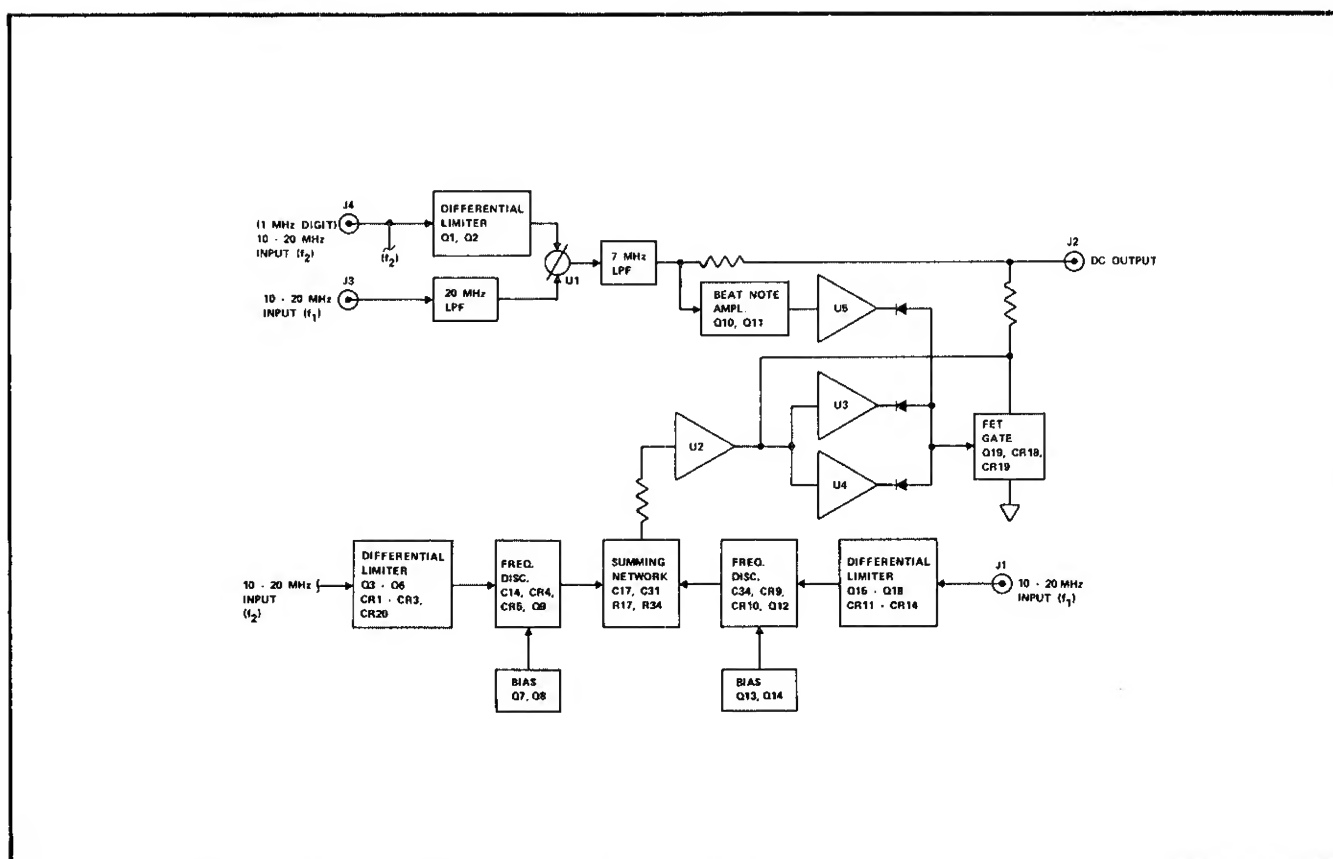


Figure 3-13. 10 MHz D. U. MAIN P. D. MODULE BLOCK DIAGRAM

3-100. Amplifiers U3 through U5 control conduction of FET gate Q19 via AND gate CR15 through CR18. FET Q19 is conducting when the difference frequency output of U1 is less than 1 MHz. A difference frequency greater than 1 MHz turns off Q19 and makes available to J2 the dc output of U2 via R49 and R51. Beat note amplifier Q10 and Q11 amplify the difference frequency output of U1 which then initiates turn-off of Q19. The collector signal of Q11 is rectified by CR6 and CR7 to provide a positive dc input to U5. Operational amplifier U5 produces a positive output under this condition which turns off CR17. Sequential with this condition, U3 and U4 (to be described later) also produce positive outputs that turn off CR15 and CR16. With CR15 through CR17 off, CR19 conducts and the resulting voltage (0V) at the junction of CR18 and R48 turns off FET, Q19. The dc output from U2 is thus summed with the difference frequency output of U1 and made available to J2.

3-101. Comparison of the 1 MHz digit section signal (J4) and the 10 MHz main loop signal (J1 and J3) is done using two discriminators shown in the block diagram. The resulting difference is then summed and converted to a dc voltage proportional to the offset. This dc voltage is made available to J2 when any difference greater than 1 MHz exists between the inputs to J1 or J4. Since both discriminators operate in an identical manner, only the one receiving an input from J4 is described. It should be noted that the input to J1 is identical, except for amplitude, with the input to J3.

3-102. The 10 to 20 MHz input to J4 is coupled via C9 to a differential limiter consisting of Q3 through Q6 and diodes CR1 through CR3 and CR20. Operation of Q3, Q4 and Q5, Q6 is similar to Q1 and Q2 described previously. Diodes CR2 and CR3 provide temperature compensated limiting of the output from Q3 and Q4. Sharp cut-off of Q3 and Q4 is provided via CR1 and CR20.

3-103. Discriminator CR4 and CR5 together with Q9 process the resulting squarewave signal coupled via C14 and produces a dc current proportional to the frequency. Temperature compensated bias is provided via Q7 and Q8. The resulting dc current from Q9 is then summed through R17 with the output of a similar discriminator, but of opposite polarity via R34. The resulting difference current is then amplified by U2 to produce a dc voltage proportional to the difference frequency between J1 and J4. This dc voltage is made available to J2 and also applied to U3 and U4. Comparator amplifiers U3 and U4 produce a turn off voltage to CR15 and CR16 (positive output) when the dc voltage is proportional to a difference frequency greater than 1 MHz.

Since beat note amplifier Q10 and Q11 also causes CR17 to be cut-off via U5 at this time, FET gate Q19 described previously is cut-off. The dc output from U2 is thus summed with the output of U1 and made available at J2.

3-104. 10 MHz D. U. Main Loop VCO Module (6160A-4110)

3-105. The 10 MHz D. U. Main Loop VCO Module (Drawing No. 6160A-1010) produces an 80 to 150 MHz output containing the 10 MHz digit information. This signal is available in 10 MHz increments and corresponds to the 10 MHz decade commands. Any previous digit information is included, thus providing a total range in output from 80.000000 to 159.99999 MHz. A block diagram of the circuitry is shown in Figure 3-14.

3-106. The dc input to J1 together with the BCD 10 MHz decade commands applied to U4 produce a dc control voltage across C6 that determines the output frequency of an 80 to 160 MHz voltage controlled oscillator (VCO). Transistors Q1 and Q3 integrate the dc input at J1 and provide fine tuning of the VCO frequency. An up frequency charge current for C6 is provided by Q1. Down frequency charge current is provided by Q3. Temperature compensation for Q1 and Q3 is provided via diode connected Q2 and Q4. Variable resistor R3 allows adjustment of the VCO frequency for a given dc input to J1.

3-107. BCD 10 MHz decade applied to U4 produce an incremental step voltage across C6 via a presteering and limit stop circuit consisting of Q10 through Q15 and U1 through U3. The inverted 1-2-4 outputs from U4 (0V = true) turn off associated diodes CR9, CR11, and CR13. Transistors Q10 through Q12 then provide 1-2-4 weighted currents via R27, R28, and R29 to operational amplifier, U3. This weighted current input to U3 is then added to its output developed across R35 through R38. Differential amplifiers U1 and U2 apply the resulting presteering current proportional to the 10 MHz decade commands to C6 via CR2 and CR3. Temperature compensation is provided by Q13. Transistors Q14 and Q15 provide a reference current input to U1 and U2, adjustable by R38. This current input establishes an upper limit stop for U1 and a lower limit stop for U2. Should the dc control voltage developed across C6 exceed the reference, U1 or U2 clamp the dc control voltage at the reference. Variable resistor R33 allows adjustment at the low end of the dc control voltage, while R36 adjusts the high end. The resulting dc control voltage is passed through a 10 MHz low-pass filter consisting of C8 through C11 and L5 to remove any ripple above 10 MHz and applied to a VCO.

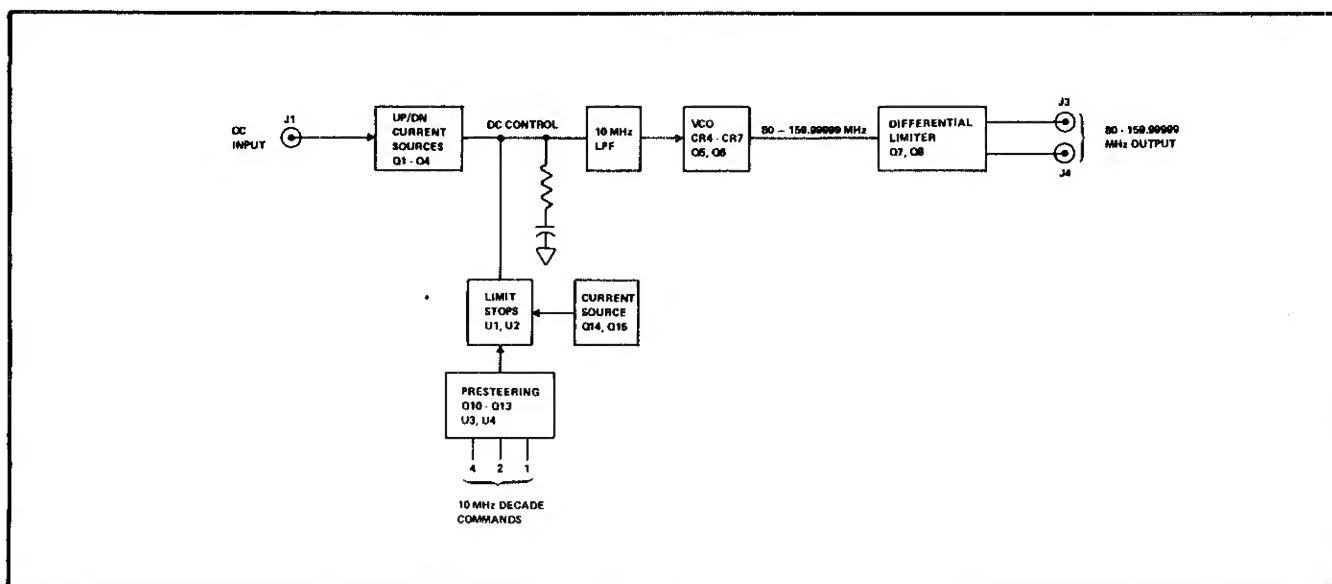


Figure 3-14. 10 MHz D. U. MAIN LOOP VCO MODULE BLOCK DIAGRAM

3-108. The VCO consisting of CR4 through CR7, Q6, Q7 and a printed circuit inductor produces an 80 to 159.99999 MHz signal dependent upon the dc control voltage across C6. Capacitance value of varicaps CR4 through CR7 depends upon the applied dc control voltage. These varicaps together with the tapped printed circuit inductor form a tuned circuit. Conduction of Q6 develops a signal which is coupled via C14 to the tuned circuit. Regenerative feedback to the base of Q6 via R15 sustains oscillations at the resonant frequency of the tuned circuit. Grounding of the emitter of Q6 is provided via the emitter-base junction of Q5. Transistor Q5 also buffers the resulting VCO output which is coupled via L8 and C18 to Q7 and Q8.

3-109. Transistors Q7 and Q8 form a differential limiter which translates the VCO signal to a symmetrical square-wave. Positive going inputs to Q7 cause it to conduct the maximum available current supplied via R24 and R25. Transistor Q8 is cut-off during this period and no output is developed at its collector. When the input to Q7 goes negative, Q7 is cut-off and Q8 conducts the maximum available current supplied via R24 and R25. The resulting squarewave signals developed across tapped inductors L9 and L10 are applied to J3 and J4.

3-110. Output Divider Module (6160A-4111)

3-111. The Output Divider Module (Drawing No. 6160A-1011) produces the final 1 to 160 MHz output of the synthesizer. It receives an 80 to 160 MHz input, band and range commands, and a dc level control voltage. The band and range commands select the appropriate dividers and

filters which then produce an output signal proportional to the preselected dial settings or remote input. Amplitude of this output signal is dependent upon the level of a dc level control voltage. A block diagram of the circuitry is shown in Figure 3-15.

3-112. **BUFFER LIMITER.** The 80 to 160 MHz input at J4 is amplified by Q2 and limited by CR15 and CR16. Amplifier Q2 has a high forward rf gain controlled by feedback through C10, R94 and L29. Capacitor C95 couples the amplified signal to limiter, CR15 and CR16. The limiting point of CR15 and CR16 is set by voltages across CR17 and CR18. Diode CR17 is biased by R110 to +5V, while CR18 is self-biased to ground. The resulting limited 80 to 160 MHz signal is coupled through C124 to the 110 to 160 MHz and 80 to 110 MHz gates. It is also coupled through C94 to a 2/1 divider, U8.

3-113. **RANGE AND BAND LOGIC.** The range and band logic consists of NAND gates U1, U2, U9 and inverters Q1, Q3. This circuitry activates the appropriate dividers and filter/gates depending on range and band logic inputs. The range command is applied to U1 and Q1. It is a 0V command when the 1 - 12 MHz range is selected. When the 10 - 160 range is selected, this input is a +5V command. Band commands applied to U1A through U1D, U2A through U2D, and U9A, U9C correspond to the preselected output in the most significant decade (1 MHz or 10 MHz). A "1" in this decade produces the 1-2 band command; a "2" or "3" the 2-4 band command; a "4, 5, 6", or "7" the 4-8 band command; an "8" or above produces the 8-16 band command. The 80-110 band command is produced only in the 10 - 160 MHz range when an "8" to "10" exist in the 10 MHz decade.

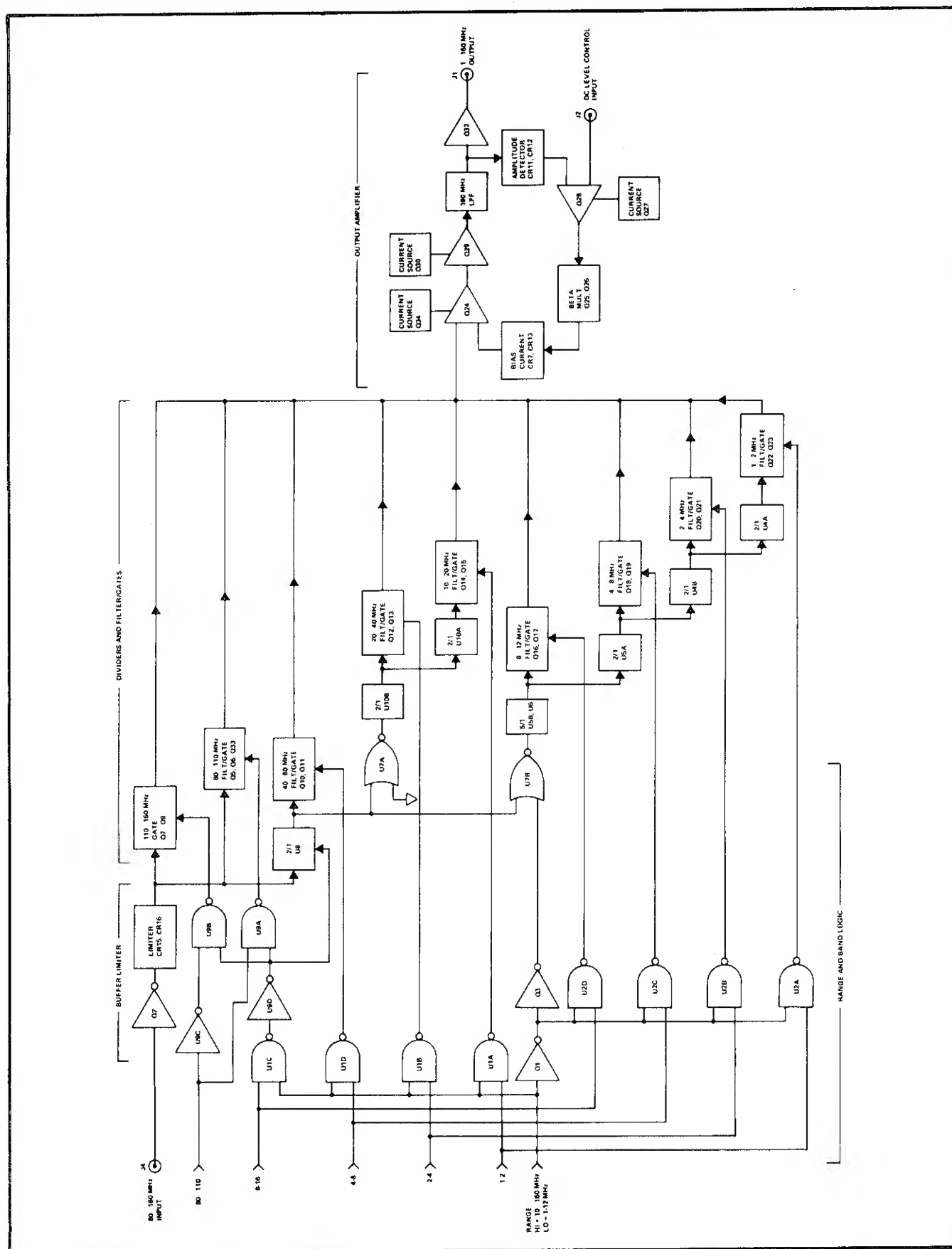


Figure 3-15. OUTPUT DIVIDER MODULE BLOCK DIAGRAM

3-114. Presence of a 10 - 160 MHz range command (+5V) will enable NAND gates U1A through U1D. Inverter Q1 conducts with this command present at its base and produces a 0V collector signal which disables NAND gates U2A through U2D. Transistor Q3 is switched on by conduction of Q1 and provides a +5V disable command to OR/NOR gate U7B. This disable command causes U7B to block the input signal to 5/1 divider U5B and U6. In the 1 - 12 MHz range, a 0V command is applied to the base of Q1. Subsequently, NAND gates U1A through U1D are disabled and Q1 is switched off. The resulting +5V collector signal of Q1 then enables NAND gates U2A through U2D. Transistor Q3 is switched off in conjunction with Q1 and enables OR/NOR gate U7B, which then passes the input signal to 5/1 divider U5B and U6.

3-115. Disabling of dividers not required to produce the preselected output is done in most cases by applying a +5V signal to the \overline{K} or C_1 input of the divider. The only exception to this is the 5/1 divider U5B and U6 described previously and the 2/1 divider U10B. The input to U10B is supplied by OR/NOR gate U7A which is controlled by U1A or U1B.

3-116. Each divider is enabled by a 0V input applied to \overline{K} or C_1 inputs. Divider U4A is enabled directly by a 0V output from U2A. Diodes CR1 and CR4 also enable dividers U4B and U5A in conjunction with U4A. Dividers U4B and U5A are separately enabled via CR2 and CR3 by a 0V output from U2B and U2C, respectively. The 0V output from U1A enables divider U10A directly. Diode CR5 enables divider U10B via OR/NOR gate U7A in conjunction with divider U10A. OR/NOR gate U7A is enabled separately via CR6 by a 0V output from U1B. Divider U8 is enabled by a 0V output of inverter U9D.

3-117. Band logic inputs to U1 and U2, in conjunction with the range command described previously, produce 0V outputs which also activate the associated 1 - 2 MHz through 40 - 80 MHz filter/gates. The 80 - 110 MHz filter/gate and 110 - 160 MHz filter/gate are activated via the combined action of U1C and U9. Presence of the 8-16 band command in the 10 - 160 MHz range produces a 0V output at pin 8 of U1C. The output of U1C is inverted by U9D and the resulting +5V signal applied to pin 2 of U9A, pin 4 of U9B, and pin 6 of U8. This signal is present at all times in the 10 - 160 MHz range. It functions as an enable input to NAND gates U9A and U9B and as a disable command for divider U8. Presence of an 80 - 110 band command provides a +5V input to pin 1 of U9A and pin 9 of inverter U9C. NAND gate U9A produces a 0V output which enables the 80 - 110 MHz filter/gate. The 110 - 160 MHz filter/gate is disabled

by the corresponding +5V output of NAND gate U9B, which receives a 0V input at pin 5 via inverter U9C. If the 80 - 110 band command is not present, inverter U9C provides a +5V input to pin 5 of U9B. NAND gate U9B then produces a 0V output which enables the 110 - 160 MHz filter/gate. The 80 - 110 MHz filter/gate is disabled by the 5V output of NAND gate U9A.

3-118. DIVIDERS. There are seven series connected dividers in this module. Individual or group activation is done by appropriate range and band logic inputs, such that the 80 - 160 MHz input is divided down to yield the preselected output. Emitter-coupled logic is standard to provide a typical output signal swing of 0.8V. A high output is approximately +4.3V and a low +3.4V.

3-119. The limited 80 to 160 MHz signal coupled through C94 is divided down to 40 to 80 MHz by 2/1 divider U8. This divider is enabled by a 0V input to pin 6 from IC9D. A +5V input to pin 6 disables its operation. Voltage divider CR19, R16 and R17 provide proper bias at the pin 8 clock input. The resulting divided down 40 to 80 MHz outputs at pins 2 and 3 are coupled through C25 and C26 and applied to T3 via R18 and R19. Transformer T3 couples the signal to the following 40 to 80 MHz filter/gate. The divider output is also applied to OR/NOR gates U7A, U7B.

3-120. OR/NOR gate U7A is enabled by a 0V input to pin 4. When enabled, it applies the 40 to 80 MHz signal from U8 to pin 12 of 2/1 divider U10B. The resulting 20 to 40 MHz outputs at pins 9 and 15 are applied to T4 via R31 and R32. Transformer T4 couples the signal to the following 20 to 40 MHz filter/gate. The divider output at pin 9 is also applied to 2/1 divider U10A.

3-121. Divider U10A is enabled by a 0V input to pin 3. When enabled, it divides the 20 to 40 MHz input at pin 4 down to a 10 to 20 MHz signal available at pins 1 and 7. The 10 to 20 MHz output is applied to T5 via R30 and R54 and coupled to the following 10 to 20 MHz filter/gate.

3-122. OR/NOR gate U7B passes the 40 to 80 MHz output of U8 when a 0V input is applied to pin 10. The 5/1 divider consisting U5B, U6A and U6B divides the input down and produces an 8 to 16 MHz signal at pin 13 of U6B and pin 9 of U5B. The output at pin 2 of U6A is applied directly to the following 8 to 12 MHz filter/gate. The output at pin 9 of U5B is applied to 2/1 divider U5A.

3-123. Divider U5A is enabled by a 0V input to pin 3. When enabled, it divides down the 8 - 16 MHz input applied

to pin 4 and produces a 4 to 8 MHz signal at pins 1 and 7. The 4 to 8 MHz output is applied to T6 via R27 and R28 and coupled to the following 4 to 8 MHz filter/gate. The divider output at pin 7 is also applied to 2/1 divider U4B.

3-124. Divider U4B is enabled by a 0V input to pin 13. When enabled, it divides down the 4 to 8 MHz input applied to pin 12 and produces a 2 to 4 MHz signal at pins 9 and 15. The 2 to 4 MHz output is applied to T7 via R25 and R26 and coupled to the following 2 to 4 MHz filter/gate. The divider output at pin 15 is also applied to 2/1 divider U4A.

3-125. Divider U4A is enabled by a 0V input to pin 3. When enabled, it divides down the 2 to 4 MHz input applied to pin 4 and produces a 1 to 2 MHz signal at pins 1 and 7. The 1 to 2 MHz output is applied to T8 via R23 and R24 and coupled to the following 1 to 2 MHz filter/gate.

3-126. FILTER/GATES. The filter/gates pass or reject the 80 to 160 MHz input and the divider outputs depending on the range and band logic commands. The resulting filtered output of the activated filter/gate corresponds to the pre-selected frequency of the synthesizer.

3-127. Two types of filter/gates are used to pass the desired frequency: two transistor and three transistor. The two transistor filter/gates are used to pass or reject frequencies below 80 MHz. Frequencies above 80 MHz are passed or rejected by three transistor filter/gates. Since operation of each two transistor gate, except for 8 to 12 MHz filter/gate Q16, Q17, and three transistor filter/gates is similar, only one of each type is described.

3-128. The two transistor 40 to 80 MHz filter/gate of Q10 and Q11 is activated by a 0V input to the base of Q10 via R39. Presence of this 0V input turns on Q10 and Q11 by providing a dc current path from +5V via R40, Q11, L4, L3, Q10 and R39 to the 0V output at pin 11 of U1D. Each transistor will saturate since their collector circuits are at a high impedance with no dc current path. The saturated transistors appear as a low impedance path to the 40 to 80 MHz signal coupled via T3, R103 and C27 to the collector of Q10. An 80 MHz low-pass filter consisting of C111 (traps C112, L3 and C43) L4, C29, and C30 rejects signal components above 80 MHz that are passed by Q10 and Q11. The filtered output is coupled by C106 to the output amplifier. Presence of a +5V output from U1D bias Q10 and Q11 off by disabling the base/emitter current path. The resulting high impedance collector/emitter path then prevents passage of the 40 to 80 MHz signal.

3-129. Filter/gate Q16 and Q17 operates in a manner similar to Q10 and Q11. Transistor Q16 is connected as an emitter-follower, and Q17 receives the turn on/off bias. Presence of a 0V input to the base of Q17 via R47 provides a dc current path from +5V via L36, Q16, R112, L9, L10, Q17 and R47. This dc current switches on Q16 and Q17 which then pass the 8 to 12 MHz signal to the output amplifier. The 12 MHz low-pass filter consisting of C109 (traps C110, L9 and C47) L10, and C48 rejects signal components above 12 MHz.

3-130. The three transistor 110 to 160 MHz filter/gate of Q7 through Q9 is activated by a 0V input to the base of Q8 via R37. Presence of this 0V input turns on Q7 through Q9 by providing a dc current path from +5V via R36, R38 and Q7, Q9, Q8, and R37 to the 0V output at pin 6 of U9B. Transistors Q7, Q9 and Q8 will saturate since their collector circuits are at a high impedance with no dc current path. The saturated transistors appear as a low impedance path to the 110 to 160 MHz input signal coupled by C21 to the collector of Q7. The signal passed by Q7 through Q9 is coupled via C108 to the output amplifier. Filtering for 110 to 160 MHz signals is done in the output amplifier.

3-131. OUTPUT AMPLIFIER. The output amplifier produces the final 1 to 160 MHz output having a level of +3 to +13 dbm into 50 ohms. Output amplitude is controlled by a dc control voltage. Transistor Q24 has a variable gain controlled by Q25, Q26 and Q28. Fixed gain is provided by Q29 and Q32. Transistors Q34, Q30 and Q31 provide a fixed dc current for Q24, Q29, and Q32, respectively.

3-132. The 1 to 160 MHz signal is first amplified by variable gain amplifier Q24. Negative feedback through L18, R58 and C68 provides gain flatness over the entire frequency range. A constant dc current through Q24 is provided by Q34 which maintains a constant voltage across R60. Variable gain is controlled by CR7 and CR13 which act as current variable resistors. These diodes are controlled by Q25, Q26 described later. The amplified collector signal of Q24 is coupled through C73 and further amplified by fixed gain amplifier Q29. A constant dc current through Q29 is provided by Q30 which maintains a constant voltage across R73. Negative feedback through L20, R69 and C75 provides gain flatness. Capacitor C82 couples the amplified output from Q29 to the 160 MHz low-pass filter composed of C87, C88, C91, C90, L24 and C77. This filter rejects signal components above 160 MHz. The resulting filtered signal is then amplified by Q32 and applied to J1. Constant dc current through Q32 is provided by Q31 which maintains a constant voltage across R86. Negative feedback through R90, R92 and C84 provides gain flatness.

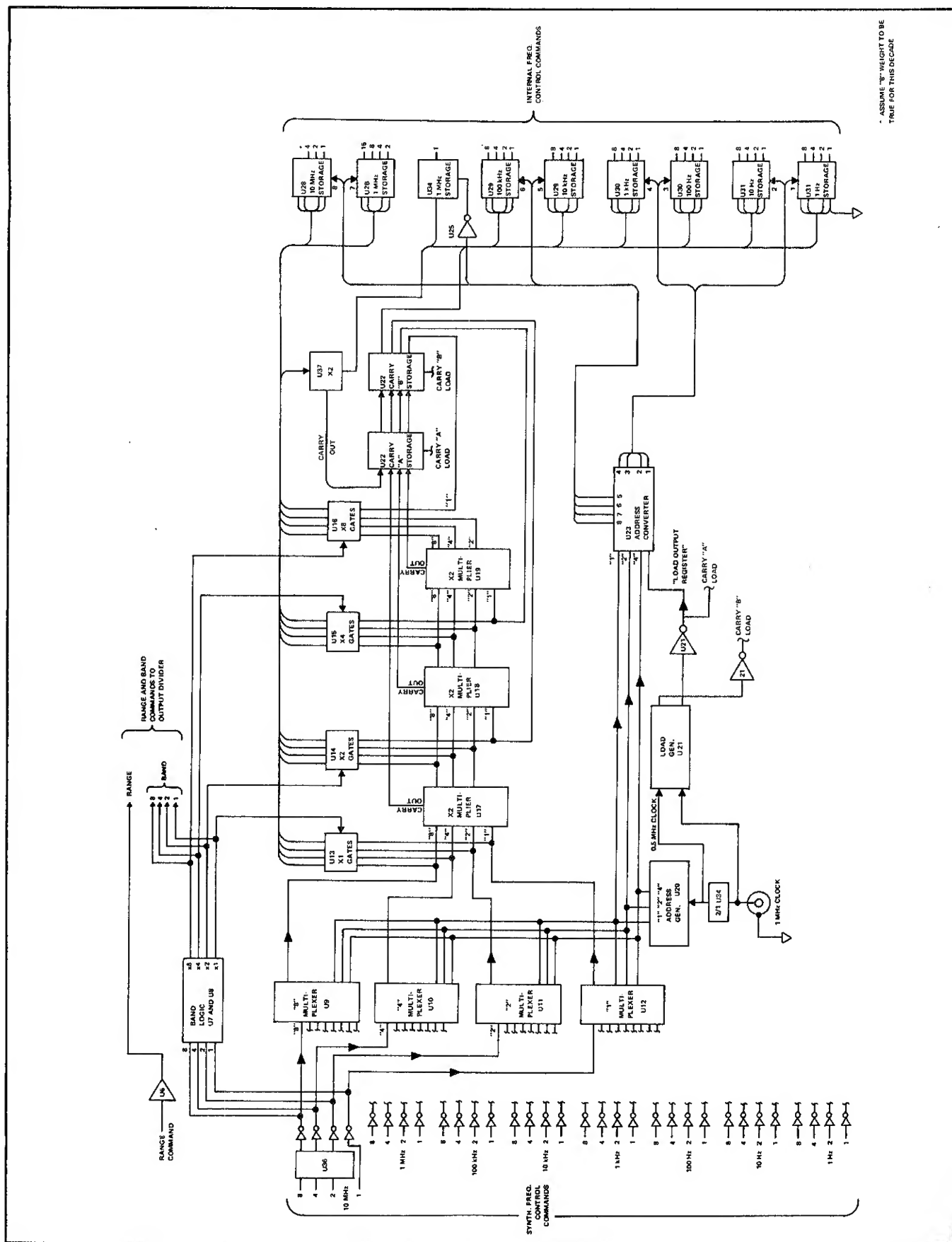


Figure 3-16. COMPUTER ASSEMBLY BLOCK DIAGRAM

3-133. The filtered output signal is also coupled via R82 and C81 to amplitude detector CR11 and CR12. The detector output developed across C80 is a dc voltage proportional to the amplitude of the rf output. This dc voltage is applied to one input of differential amplifier Q28 which receives a variable dc control at its other input from J2. The variable dc control voltage is derived from the front panel LEVEL control or an external source via the rear panel. Differential amplifier Q28 compares its two inputs and produces a difference output which is applied to Q26. Transistor Q27 provides a constant current for Q28. The difference output from Q28 is amplified by Q26 and Q25 which control the gain of Q24. Any difference in the detected output level and the dc control voltage subsequently alters the gain of Q24 until both inputs to Q28 are equal. As a result, the output level is maintained to nominally ± 1 db of the preset level over the 1 to 160 MHz range.

3-134. Computer Assembly (6160B-4012)

3-135. The Computer Assembly (Drawing No. 6160B-1012) receives manual or remote synthesizer frequency control commands and converts them to internal frequency control commands. A block diagram of the circuitry is shown in Figure 3-16.

3-136. Manual commands from the front panel switches are introduced through J3 and J4. Selection of local command is accomplished by disconnecting power to gates U1 through U5 and grounding the common frequency selector switch bus on the front panel. This is accomplished by setting the front panel FUNCTION switch to the 1 - 12 MHz or 10 - 160 MHz position.

3-137. Remote commands arrive through J16. Setting the front panel FUNCTION switch to REMOTE applies power to gates U1 through U5. The common frequency selector bus on the front panel is ungrounded, thereby preventing the outputs of gates U1 through U5 from being pulled low (0V) through the front panel switches. Resistors R1 through R31 provide multiplexer input current when the multiplexer inputs are in a high (+5V) state. U36 combines the BCD bits of the 10 MHz decade with the 1 bit of the 100 MHz decade to provide a binary coded 10 MHz digit with legitimate states of 1 through 15. Inverters U6C and U6F control the remote range. The outputs of gates U1 through U5C are applied to the 1, 2, 4, and 8 multiplexers U9 through U12. The output of gates U5D, U5E, U6A and U6B is applied to the band logic circuitry.

3-138. BAND LOGIC. The Band Logic circuitry consists of inverters U7 and NAND gates U8 and U33. The band

logic decodes the 10 MHz digit information and selects the appropriate x1, x2, x4, or x8 gates. NAND gate U8-12 and inverter U7-12 decode the 1 - 2 band command. NAND gate U8-6 and inverters U7-10 and U7-2 decode the 2 - 4 band command. NAND gate U8-8 and inverters U7-4 and U7-8 decode the 4 - 8 band command. Inverter U7-6 supplies the 8 - 16 band command. The logic at inverters U7 is also applied to the x1, x2, x4 and x8 gates.

3-139. CLOCK AND LOAD GENERATOR. The Clock and Load Generator circuitry consists of NAND gates U35-11, U35-3, U35-8, NOR gates U21-1 through -13, and load generator U34. A 1 MHz clock signal is applied to NAND gates U35-11, -3, and -8. After inversion, the signal the signal is applied to a binary circuit within U20. The output of this binary circuit, pin 1, is then applied to the load generator U34 and NAND gates U21-10 and U21-13. The load generator is also driven by the 1 MHz output of NAND gate U35-8. The outputs of U20 and U34 are gated together with NAND gates U21-1, U21-10, and U21-13 to produce 4 discrete phases of the 500 kHz clock. Figure 3-17 shows the waveshapes of this circuitry.

3-140. MULTIPLEXERS. The Multiplexer circuitry sequentially presents decade bit information of the 1, 10, 100 Hz, kHz, and 1 and 10 MHz decades to the x2, Multiplier and x1 gate circuitry. The multiplexing is done under command of the address generator U20. The multiplexer circuitry consists of multiplexers U9 through U12. U9 is the "8" multiplexer, U10 the "4" multiplexer, while U11 is the "2" multiplexer and U12 the "1" multiplexer.

3-141. X2 MULTIPLIERS. The X2 Multiplier circuitry consists of U17, U18, and U19. The first x2 Multiplier, U17, receives the serial input from multiplexers U9 through U12 and multiplies that input by a factor of two. The second multiplier U18 multiplies the output of the first multiplier by a factor of two, thereby achieving a total multiplication of four. U19, the third multiplier multiplies the output of the second multiplier by a factor of two, thereby achieving a total multiplication of eight. The 2, 4, and 8 output lines of the multipliers command the x2, x4, and x8 gates while the 1 line is fed to the Carry Storage Circuit U22. Table 3-1 shows input/output logic for any given multiplier.

3-142. X1, X2, X4, X8 GATES. The Multiplier Gates, NAND gates U13 through U16, select the desired multiplier output (x1, x2, x4, or x8) to be loaded into the storage circuitry. Selection of the appropriate gate is ac-

complied by command signals from the band logic circuitry. Inverter U25 inverts the selected gate output and applies the time multiplexed command to the input of the storage registers U28 and U37.

Table 3-1. X2 MULTIPLIER INPUT/OUTPUT LOGIC

COM- MAND	INPUT				BIT PIN	OUTPUT			
	1	2	4	8		*3	5	4	4
0	0	0	0	0			0	0	0
1	1	0	0	0			0	1	0
2	0	1	0	0			0	0	1
3	1	1	0	0			0	1	1
4	0	0	1	0			0	0	1
5	1	0	1	0			1	0	0
6	0	1	1	0			1	1	0
7	1	1	1	0			1	0	1
8	0	0	0	1			1	1	1
9	1	0	0	1			1	0	1

* Carry Output

3-143. CARRY STORAGE. The Carry Storage Circuitry, U22, is broken into two separate functions labeled carry storage A and carry storage B. During phase C of the clock period, carry storage A is loaded to store any multiplier carry outputs. At phase A of the following 500 kHz clock cycle, the contents of carry storage A is transferred into carry storage B to become the 1 bit input to the succeeding multiplier. NAND gates U33-3, U33-8, and U33-11 supply overriding commands to the 1, 2, and 4 multiplexers to prevent carry bits from being transferred from the 10 MHz decade to the 1 Hz decade at the end of each sweep through the decades.

3-144. ADDRESS CONVERTER. The Address Converter, U23, converts the 3 bit address code generated by the address generator, U20, into 8 discrete outputs. Inverters U24 and U25 invert the outputs of U20 and sequentially command the proper storage register for loading.

3-145. STORAGE REGISTER. The Storage Register circuitry consists of U28 through U31, each being a dual quad latch. Storage information is received through the x1, x2, x4, and x8 gates. The proper storage register to be loaded is commanded by the address converter. The output lines of the storage registers are applied to either J5 or

J7. NAND gate U32 generates the 80 - 110 command utilized in the Output Divider Module (6160A-4111).

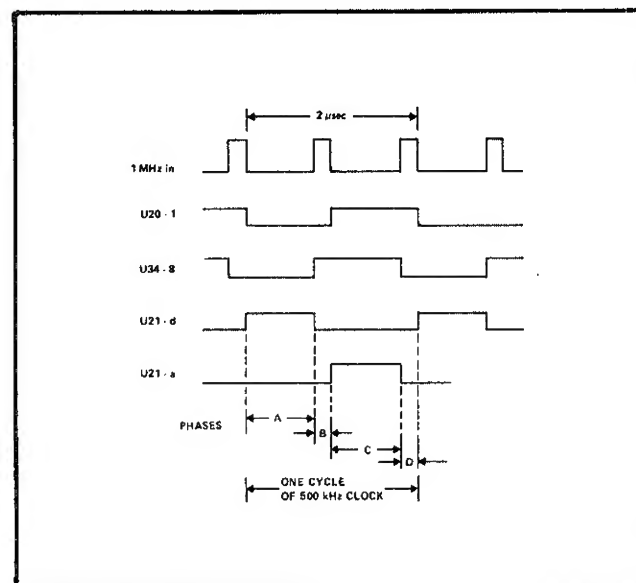


Figure 3-17. CLOCK AND LOAD GENERATOR WAVESHAPES.

3-146. X2 MULTIPLIER. U37 multiplies the inputs to U29, U30, and U31. Carry outputs of U37 are stored in carry storage A and B, as described in paragraph 3-143. These become the "1" bit input to succeeding digits. The carry output of the 100 kHz digit is stored in U34 to become the 1 MHz bit to the 1 MHz Digit Generator. The "1" bit of the 1 Hz storage is wired to "0" to prevent loading of 10 MHz carries in the 1 Hz digit.

Section 4

Maintenance

4-1. INTRODUCTION

4-2. This section contains information and instructions concerning preventive and corrective maintenance for the Model 6160B Frequency Synthesizer. The information and instructions are arranged under headings of "SERVICE INFORMATION, MAINTENANCE ACCESS, GENERAL MAINTENANCE, OPERATIONAL CHECK AND ADJUSTMENT, MODULE ALIGNMENT, and TROUBLESHOOTING.

4-3. A list of test equipment required to service the synthesizer is contained in Table 4-1. If the recommended equipment is not available, other equipment having equivalent specifications may be used.

4-4. SERVICE INFORMATION

4-5. Each synthesizer that is manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-6. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A complete list of these authorized service centers is located at the rear of the manual. Shipping information is given in Section 2, paragraph 2-3. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

Table 4-1. REQUIRED TEST EQUIPMENT

EQUIPMENT NOMENCLATURE	RECOMMENDED EQUIPMENT
Frequency Counter	Fluke Model 1952A 079
RF Voltmeter	H. P. Model 411
Oscilloscope	Tektronix Model 454
Spectrum Analyzer	H. P. Model 8551 B/851 B
Loads	50 Ω , @12W, 2.2k, @15W, 1k, 33k, 39k, 3M, 3.3M, 130 Ω , @¼W
Digital Voltmeter	Fluke Model 8200A
DC Voltage Calibrator	Fluke Model 341A
Power Supplies: +5V dc, +14V dc -12V dc	Harrison Lab, Model 865B Acoptan Model LL
120 db, 10 db Step Attenuator	H.P. Model 355D
Signal Generators: 50 kHz - 65 MHz 10 MHz - 480 MHz	H.P. Model 606 H.P. Model 608C (2)
Splitter, 6 db	Three 50 ohm resistors in delta configuration
Multimeter	Fluke Model 8000A

4-7. MAINTENANCE ACCESS**4-8. Major Section Access**

4-9. To gain access to the major sections of the synthesizer, proceed as follows:

- a. Turn off the synthesizer and disconnect the power cord.
- b. Set the synthesizer on its left side.

NOTE!

If the synthesizer is rack mounted, slide it out until the chassis slides lock in the extended position.

- c. Remove the top and bottom dust covers. Access is now provided to the modules shown in Figure 4-1.
- d. Remove the output divider. Access is now provided to the plug-in assembly.

4-10. Module Removal

4-11. To remove a module, proceed as follows:

- a. Disconnect cabling and wiring.
- b. Remove screws securing module and remove the module from synthesizer.

NOTE!

When reassembling module into synthesizer, refer to Figure 4-2 for wiring connections. Refer to Block Diagram 6160B-1501 for cabling connections. When attaching cabling to modules, carefully align cable connector and mating connector on module before plugging together.

4-12. Plug-in Printed Circuit Card Removal

4-13. Only one plug-in pcb assembly, Power Supply Regulator, is in the synthesizer. It is located under the Output Divider module. Access and removal of the pcb card is as follows:

- a. Gain access to pcb by removing Output Divider module, see Figure 4-1 for location.

- b. Remove plug-in board by using a constant lifting force accompanied by a gentle rocking motion.

NOTE!

A riser card for servicing is installed beside the pcb assembly.

4-14. Hinged Printed Circuit Assembly Access

4-15. To service the hinged printed circuit assemblies, proceed as follows:

- a. Remove retaining (at rear-panel end of assembly) screws which hold the assembly in place.
- b. Lift the assembly away from the synthesizer until the hinge locking bracket snaps in the locked or extended position.

4-16. Front Panel PCB Access

4-17. To service the front panel printed circuit assembly, proceed as follows:

- a. Disconnect cabling from front panel printed circuit assembly to computer board at the computer board.
- b. Remove decals from corner handle sides.
- c. Remove four (4) screws from each corner handle side.
- d. Disconnect RF OUTPUT cable from inside connection.
- e. Pull front panel assembly away from chassis.
- f. Remove knobs from front panel.
- g. Disconnect indicator leads from front panel printed circuit assembly.
- h. Remove five (5) mounting nuts from the rear of the front panel PCB assembly.
- i. Pull front panel away from front panel PCB assembly. (Switch mounting bracket will remain with PCB).
- j. Remove switch mounting nuts from front of switch mounting bracket and separate bracket from PCB. Access is now gained to service the switch assembly.

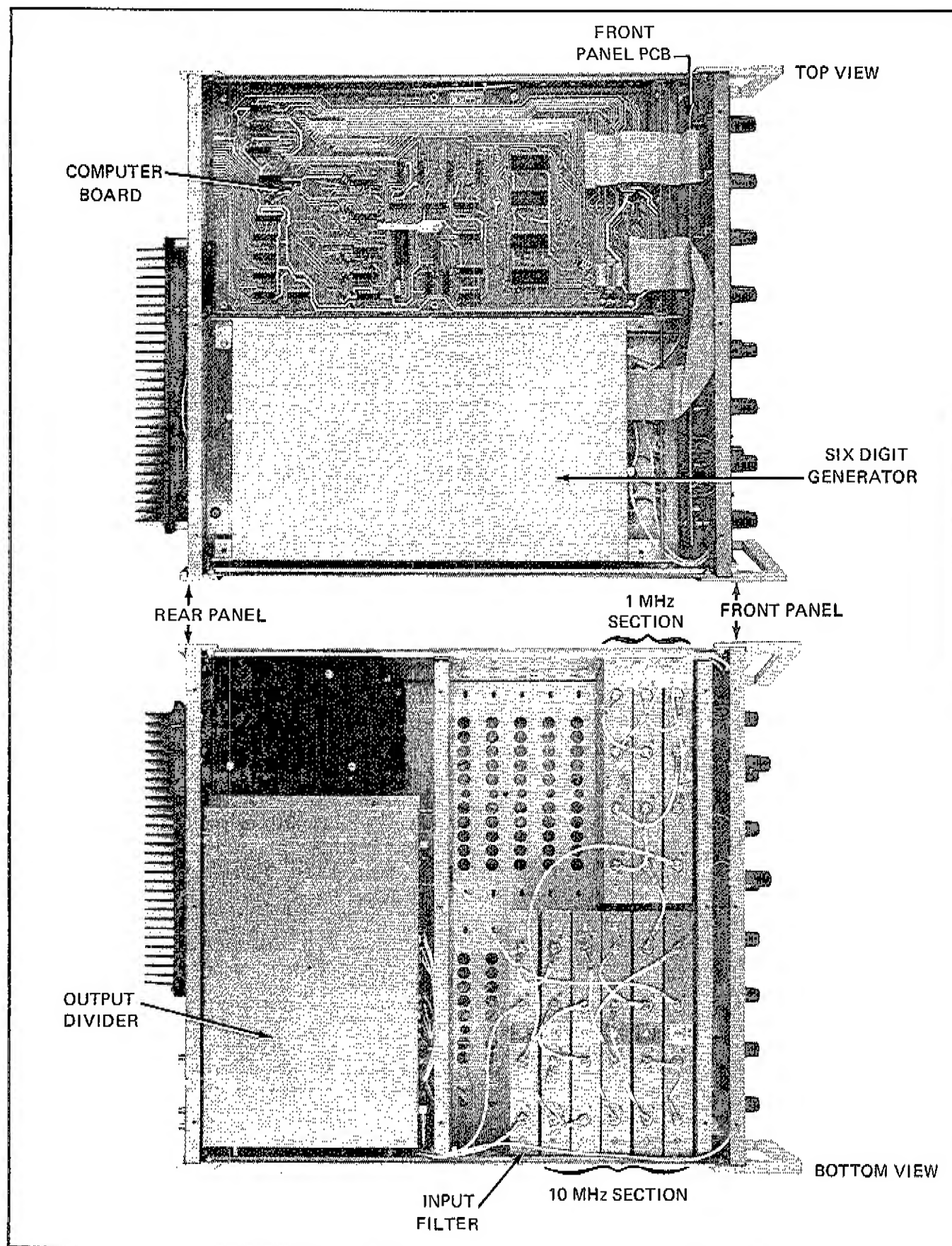


Figure 4-1. SECTION LOCATIONS

4-18. GENERAL MAINTENANCE**4-19. Cleaning**

4-20. Clean the instrument periodically to remove dust, grease, and other contamination. Use the following procedure:

- a. Clean the interior with clean, dry air at low pressure. When the printed circuit boards require cleaning, first spray them with Freon T.F. Degreaser (Miller Stephensen Company, Inc.) and then remove the dirt with clean, dry air at low pressure.
- b. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

4-21. Fuse Replacement

4-22. There are two fuses located in bayonet fuseholders on the rear panel. These fuses protect the ac power circuitry from overloads. When replacing these fuses, use 1.5A Slo-Blo for 115 Vac line power.

4-23. Lamp Replacement

4-24. The decimal, POWER, and INVALID FREQUENCY indicators are located on the front panel and can be removed without any special tools. To remove these indicators, proceed as follows:

- a. Remove top and bottom covers.
- b. Disconnect leads from defective indicator to switch pcb.
- c. Push bushing and defective indicator out of front panel by applying pressure from inside the front panel.
- d. Remove thermofit sleeving and desolder connections from indicator to connector leads.
- e. Replace defective indicator with Fairchild VLV 102, John Fluke Part No. 309617.
- f. Install indicator using the preceeding procedure in reverse.

4-25. OPERATIONAL CHECKS AND ADJUSTMENTS

4-26. The following procedure checks the overall operation of the frequency synthesizer. It also includes minor adjustments for power supplies and RF output level. This procedure should be used after corrective maintenance has been performed. The following test equipment will be required:

- a. Digital Voltmeter
- b. RF Voltmeter with compensated in-line 50 ohm load.
- c. Frequency Counter
- d. Variable DC Voltage Source
- e. 50 ohm coax. cable for counter
- f. 50 ohm resistive load

4-27. Front Panel

- a. Set controls as follows:

FUNCTION Switch	OFF
10 MHz Frequency Dial	15
OUTPUT LEVEL Control	+13 dBm
LEVEL CONT (rear panel)	INT

- b. Terminate RF OUTPUT connector with 50 ohm load.
- c. Connect a 5 MHz frequency standard to 5 MHz INPUT CONNECTOR, (J2) on rear panel.

NOTE!

If -02 or -05 internal frequency standard options are installed, connect the STD OUTPUT (J1) connector to 5 MHz INPUT (J2) connector with the patch cable provided.

- d. Connect line cord to power source.
- e. Turn FUNCTION switch to 1-12 MHz position and verify that POWER indicator, INVALID FREQ indicator, and left decimal indicator illuminate.

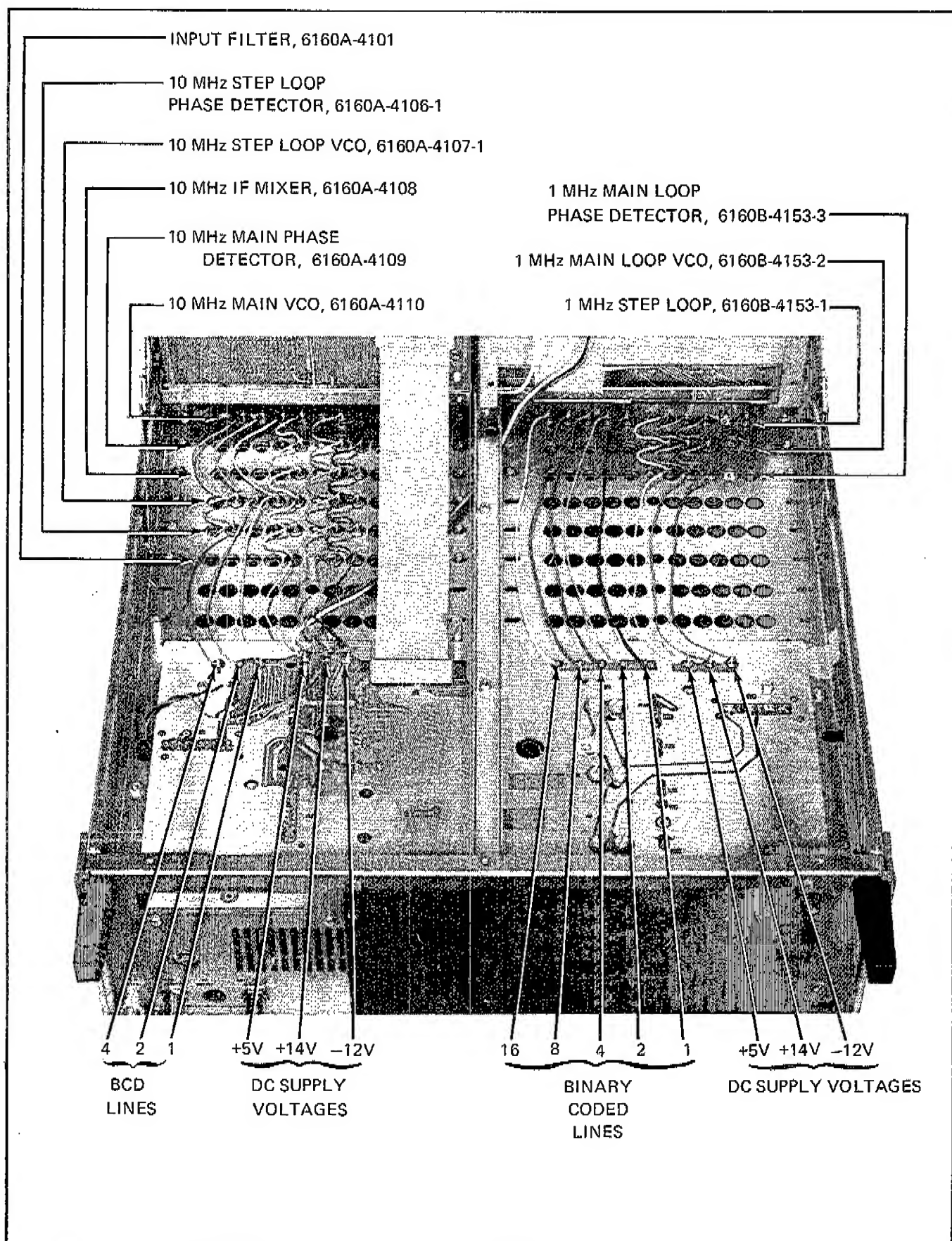


Figure 4-2. MODULE WIRING CONNECTIONS

- f. Turn FUNCTION switch to 10–160 MHz and check that INVALID FREQ indicator and left decimal indicator are extinguished, but right decimal indicator illuminates.

4-28. Power Supplies

- Remove top cover of instrument.
- Remove five screws securing Computer Board and tilt board up to allow access to module tray and Mother Board PCB.
- Refer to Figure 4-3 and connect DVM between synthesizer chassis and –12V connector on the 10 MHz Step Loop module, 6160A-4107-1. DVM should indicate –12 Vdc \pm 3 mV. Adjust R40 if necessary (See Figure 4-3 for location).
- Refer to Figure 4-3 and connect DVM between chassis and +14V connector on 10 MHz Step Loop module, 6160A-4107-1. DVM should indicate +14 Vdc \pm 3 mV. Adjust R21 if necessary (See Figure 4-3 for location).
- Refer to Figure 4-3 and connect DVM between chassis and +5V connector on 10 MHz Step Loop module, 6160A-4107-1. Check DVM indication to be +5 Vdc \pm 15 mV.
- Disconnect DVM and secure computer board to chassis. Install top cover on instrument.

4-29. Local Frequency Control

- Connect frequency counter through 50 ohm coax cable to RF OUTPUT. Terminate cable with 50 ohm load at counter input. Gate counter with signal derived from synthesizer's frequency standard. (For synthesizers with –02 or –05 Options installed, obtain gate signal from BUFF 5 MHz OUTPUT on rear panel.)
- Set frequency dials to frequencies listed in Table 4-2. Output frequency should be \pm 1 count, for counter ambiguity, from dialed frequency. (These particular frequencies are not random but are chosen to exercise all digital commands from the computer for each decade.)

4-30. Remote Frequency Control

- Set FUNCTION switch to REMOTE FREQ CONTROL.
- Connect remote programming source to REMOTE FREQUENCY CONTROL connector on rear panel.
- Program frequencies listed in Table 4-2. Output should be \pm 1 count from programmed frequency.

Table 4-2. FREQUENCY CONTROL CHECK POINTS

RANGE	FREQUENCY	RANGE	FREQUENCY
10-160 MHz	80.000000	10-160 MHz	40.875000
	81.111111		80.650000
	82.222222		20.650000
	93.333333		19.500000
	104.444444		39.500000
	115.555555		79.500000
	126.666666		42.250000
	137.777777		125.250000
	148.888888	1-12 MHz	1.9990000
	159.999999		3.9990000
	10.875000		7.9247500
	30.875000		8.0004997

- Disconnect remote programming source from synthesizer and set FUNCTION switch to 10-160MHz LOCAL FREQ CONTROL.

4-31. 5 MHz Output

- Connect rf voltmeter through 50 ohm in-line load to BUFF 5 MHz OUTPUT (J4).
- Indication on rf voltmeter should be +13 dBm \pm 2 dB.
- Remove rf voltmeter. Connect frequency counter through 50 ohm coax cable to the BUFF 5 MHz OUTPUT (J4). Counter input should be terminated with 50 ohm load. Gate counter with signal derived from synthesizer's frequency standard.
- Counter should indicate 5 MHz \pm 0.1 Hz.
- Remove counter.
- If –02 Option is installed, perform step g. If –05 Option is installed, perform step h.

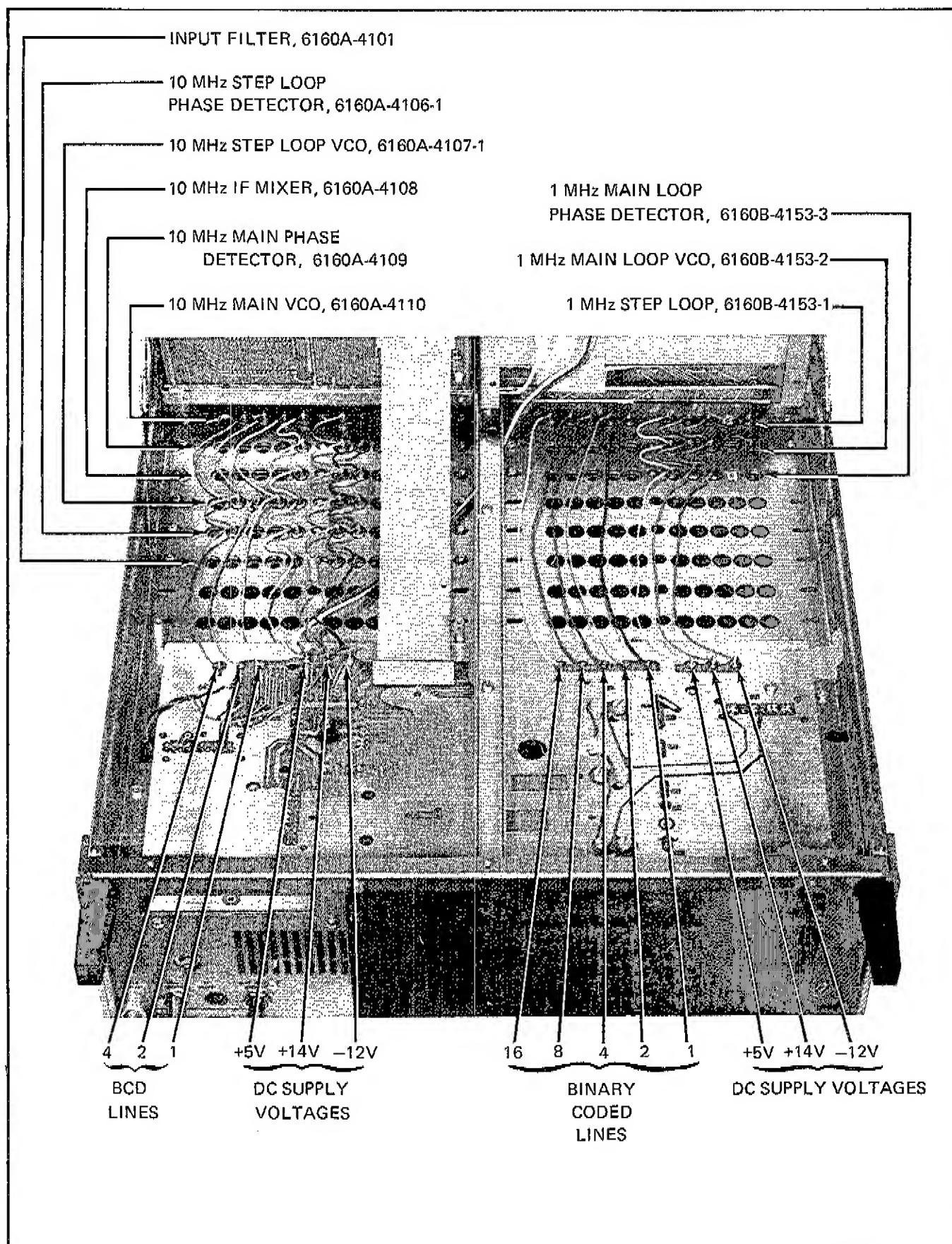


Figure 4-2. MODULE WIRING CONNECTIONS

- f. Turn FUNCTION switch to 10–160 MHz and check that INVALID FREQ indicator and left decimal indicator are extinguished, but right decimal indicator illuminates.

4-28. Power Supplies

- Remove top cover of instrument.
- Remove five screws securing Computer Board and tilt board up to allow access to module tray and Mother Board PCB.
- Refer to Figure 4-3 and connect DVM between synthesizer chassis and –12V connector on the 10 MHz Step Loop module, 6160A-4107-1. DVM should indicate –12 Vdc \pm 3 mV. Adjust R40 if necessary (See Figure 4-3 for location).
- Refer to Figure 4-3 and connect DVM between chassis and +14V connector on 10 MHz Step Loop module, 6160A-4107-1. DVM should indicate +14 Vdc \pm 3 mV. Adjust R21 if necessary (See Figure 4-3 for location).
- Refer to Figure 4-3 and connect DVM between chassis and +5V connector on 10 MHz Step Loop module, 6160A-4107-1. Check DVM indication to be +5 Vdc \pm 15 mV.
- Disconnect DVM and secure computer board to chassis. Install top cover on instrument.

4-29. Local Frequency Control

- Connect frequency counter through 50 ohm coax cable to RF OUTPUT. Terminate cable with 50 ohm load at counter input. Gate counter with signal derived from synthesizer's frequency standard. (For synthesizers with –02 or –05 Options installed, obtain gate signal from BUFF 5 MHz OUTPUT on rear panel.)
- Set frequency dials to frequencies listed in Table 4-2. Output frequency should be \pm 1 count, for counter ambiguity, from dialed frequency. (These particular frequencies are not random but are chosen to exercise all digital commands from the computer for each decade.)

4-30. Remote Frequency Control

- Set FUNCTION switch to REMOTE FREQ CONTROL.
- Connect remote programming source to REMOTE FREQUENCY CONTROL connector on rear panel.
- Program frequencies listed in Table 4-2. Output should be \pm 1 count from programmed frequency.

Table 4-2. FREQUENCY CONTROL CHECK POINTS

RANGE	FREQUENCY	RANGE	FREQUENCY
10-160 MHz	80.000000	10-160 MHz	40.875000
	81.111111		80.650000
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	104.444444		39.500000
	115.555555		79.500000
	126.666666		42.250000
	137.777777		125.250000
	148.888888	1-12 MHz	1.9990000
	159.999999		3.9990000
	10.875000		7.9247500
	30.875000		8.0004997

- Disconnect remote programming source from synthesizer and set FUNCTION switch to 10-160MHz LOCAL FREQ CONTROL.

4-31. 5 MHz Output

- Connect rf voltmeter through 50 ohm in-line load to BUFF 5 MHz OUTPUT (J4).
- Indication on rf voltmeter should be +13 dBm \pm 2 dB.
- Remove rf voltmeter. Connect frequency counter through 50 ohm coax cable to the BUFF 5 MHz OUTPUT (J4). Counter input should be terminated with 50 ohm load. Gate counter with signal derived from synthesizer's frequency standard.
- Counter should indicate 5 MHz \pm 0.1 Hz.
- Remove counter.
- If –02 Option is installed, perform step g. If –05 Option is installed, perform step h.

10 MHz STEP LOOP VCO, 6160A-4107-1

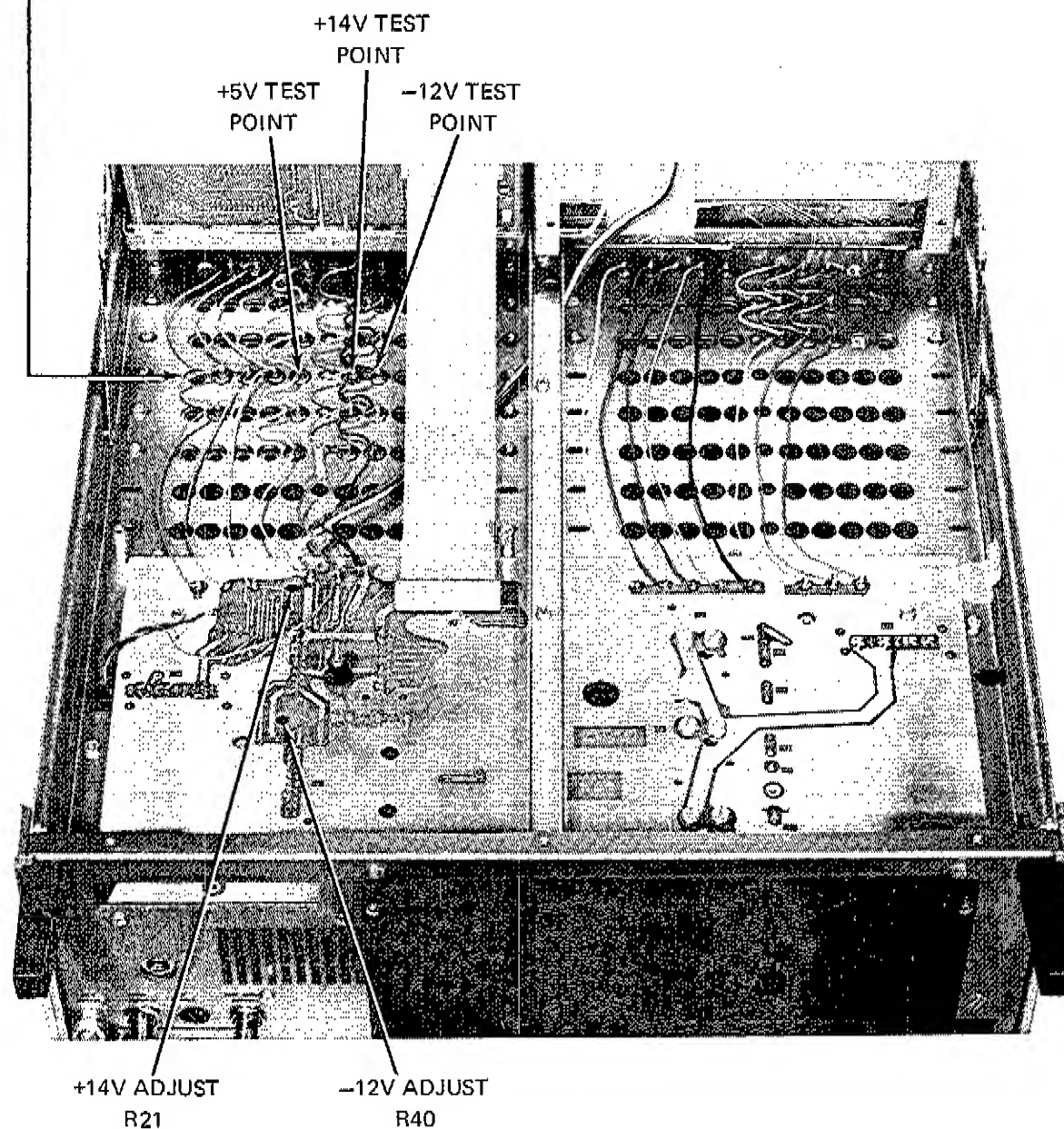


Figure 4-3. POWER SUPPLY TEST POINTS AND ADJUSTMENTS.

- g. Connect rf voltmeter through 50 ohm in-line load to STD OUT (J1). Output level of -02 Option is 13 dBm \pm 2 dB.
- h. Connect BNC "T" to 5 MHz INPUT (J2), Jumper STD OUT (J1) to one side of BNC "T". Connect RF Voltmeter to other side of BNC "T". Output level for the -05 Option is 0 dBm \pm 2 dB.
- i. Disconnect rf voltmeter and BNC "T".
- f. Rotate highest frequency dial through positions 1 to 12 and observe that rf voltmeter indicates +3 dBm \pm 1 dB. If necessary, adjust R6 (refer to Figure 4-4 for location).
- g. Set FUNCTION switch to 10-160 MHz and repeat Step f, but rotate frequency dial through positions 1 to 15.
- h. If necessary repeat steps b through g until output levels at +3 dBm and +13 dBm are flat to \pm 1 dB throughout the frequency range dialed.

4-32. RF Output Level

- a. Connect rf voltmeter through 50 ohm in-line load to RF OUTPUT connector on front panel.
- b. Set OUTPUT LEVEL control to +13 dBm position.
- c. Rotate highest frequency dial through positions 1 to 15 and observe that indication on rf voltmeter is +13 dBm \pm 1 dB. If necessary, adjust R4 (refer to Figure 4-4 for location).
- d. Set FUNCTION switch to 1-12 MHz and repeat Step c, but rotate frequency dial through positions 1 to 12.
- e. Set OUTPUT LEVEL control to +3 dBm position.

4-33. External Level Control

- a. Set LEVEL CONT switch on rear panel to EXT position.
- b. Connect rf voltmeter through 50 ohm in-line load to RF OUTPUT connector on front panel.
- c. Set frequency dials to 40 MHz.
- d. Connect variable dc voltage source to LEVEL CONT INPUT connector on rear panel.

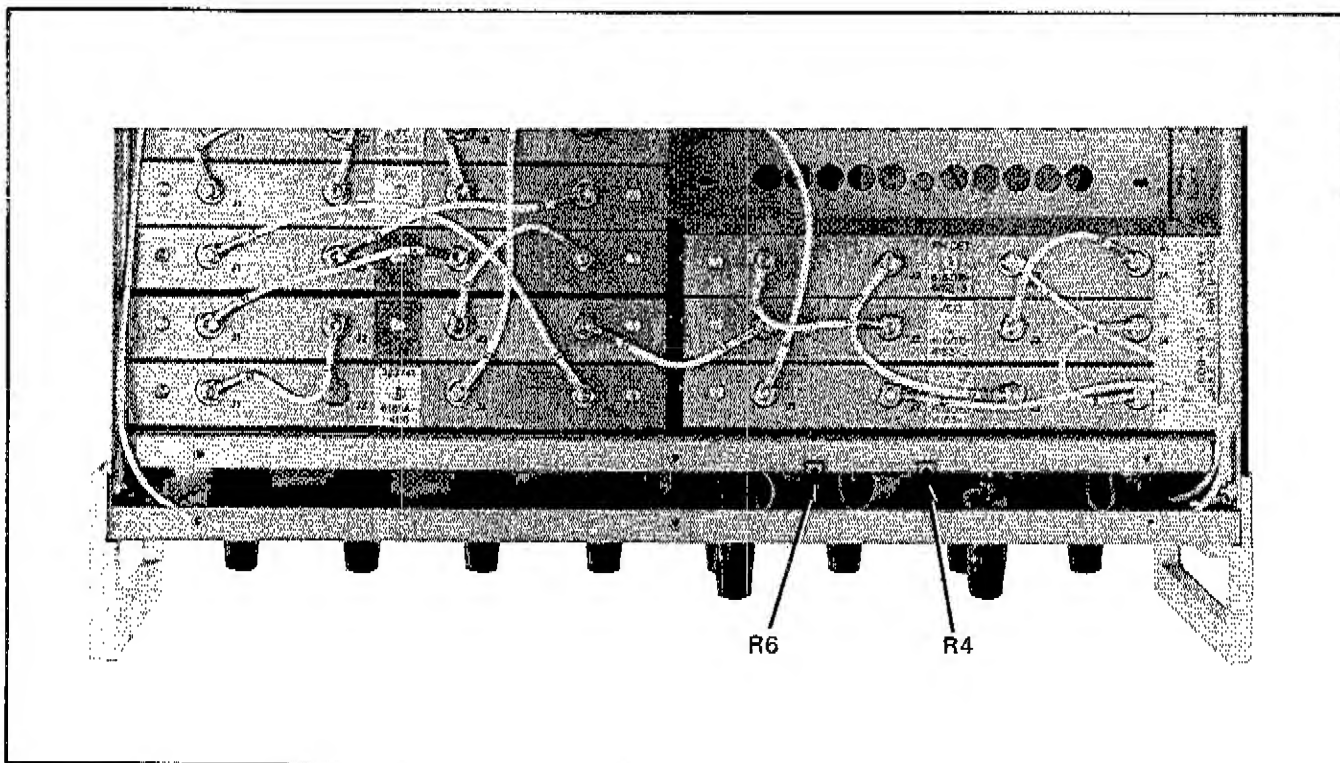


Figure 4-4. OUTPUT LEVEL ADJUSTMENTS

- c. Adjust dc voltage source until rf voltmeter indicates +5 dBm. Output of voltage source should be 325 mVdc \pm 50 mV.
- f. Increase dc voltage source output until rf voltmeter indicates +10 dBm. Output of voltage source should be 525 mVdc \pm 50 mV.
- g. Increase voltage source output until rf voltmeter indicates +13 dBm. Output of voltage source should be 725 mVdc \pm 50 mV.
- h. Disconnect all test equipment and set LEVEL-CONT switch to INT.

4-34. MODULE ALIGNMENT

4-35. The Model 6160B modules were completely aligned and tested before leaving the factory. They should not require realignment unless corrective maintenance is performed. Realignment or testing should be necessary only on the module or modules which have been repaired.

4-36. Test equipment required to align or test the modules is listed at the beginning of each procedure. A composite listing of recommended test equipment is listed in Table 4-1. Adjustment and test point locations are shown in illustrations included with each procedure.

NOTE!

A service kit (6160A-7006), JF part number 339002, is available for use in alignment or troubleshooting the Model 6160B.

4-37. Alignment or Test Signals

4-38. Module alignment or testing requires input power of +5, +14, and -12 V dc, in addition to specific rf signals. These inputs can be obtained from the test equipment listed in Table 4-1 or directly from the synthesizer.

4-39. Power Supply Regulator Assembly (6160A-4014)

4-40. Alignment of this assembly is done in the synthesizer using the following equipment.

- a. Digital Voltmeter
- b. Resistor, 100 Ω , 2W, \pm 10% (JF part number 109934).

4-41. Align the assembly using the following procedure. Test point and adjustment locations are shown in Figure 4-5.

- a. Disconnect power and remove the five screws securing the computer PCB assembly. Lift the assembly until the hinge locks.
- b. Connect a digital voltmeter between the -12V terminal on the Motherboard and chassis.
- c. Program power on and set -12V adjust for a -12.000V indication on voltmeter.
- d. Touch the 100 ohm 2 watt resistor between the ground plane on the Motherboard and -12V terminal. Voltmeter indication should not change more than 1 mV.
- e. Remove the resistor and connect the voltmeter between the +14V terminal and chassis.
- f. Set the +14V Adjust for a +14.000V indication on the voltmeter.
- g. Touch the 100 ohm resistor between the pcb ground plane and the +14V terminal. Indication on the voltmeter should not change more than 1 mV.
- h. Remove resistor and connect voltmeter between the +5V terminal and chassis.
- i. Jumper the +14V CONT and -12V CONT to chassis (See Figure 4-17)
- j. Voltmeter should indicate +5V \pm 20 mV. Note reading.
- k. Disconnect interface cable at J8 on Motherboard and note voltmeter indication. Difference between this reading and reading noted in step j should be less than 2 mV.
- l. Reconnect cable to J8. Remove jumpers and test equipment.

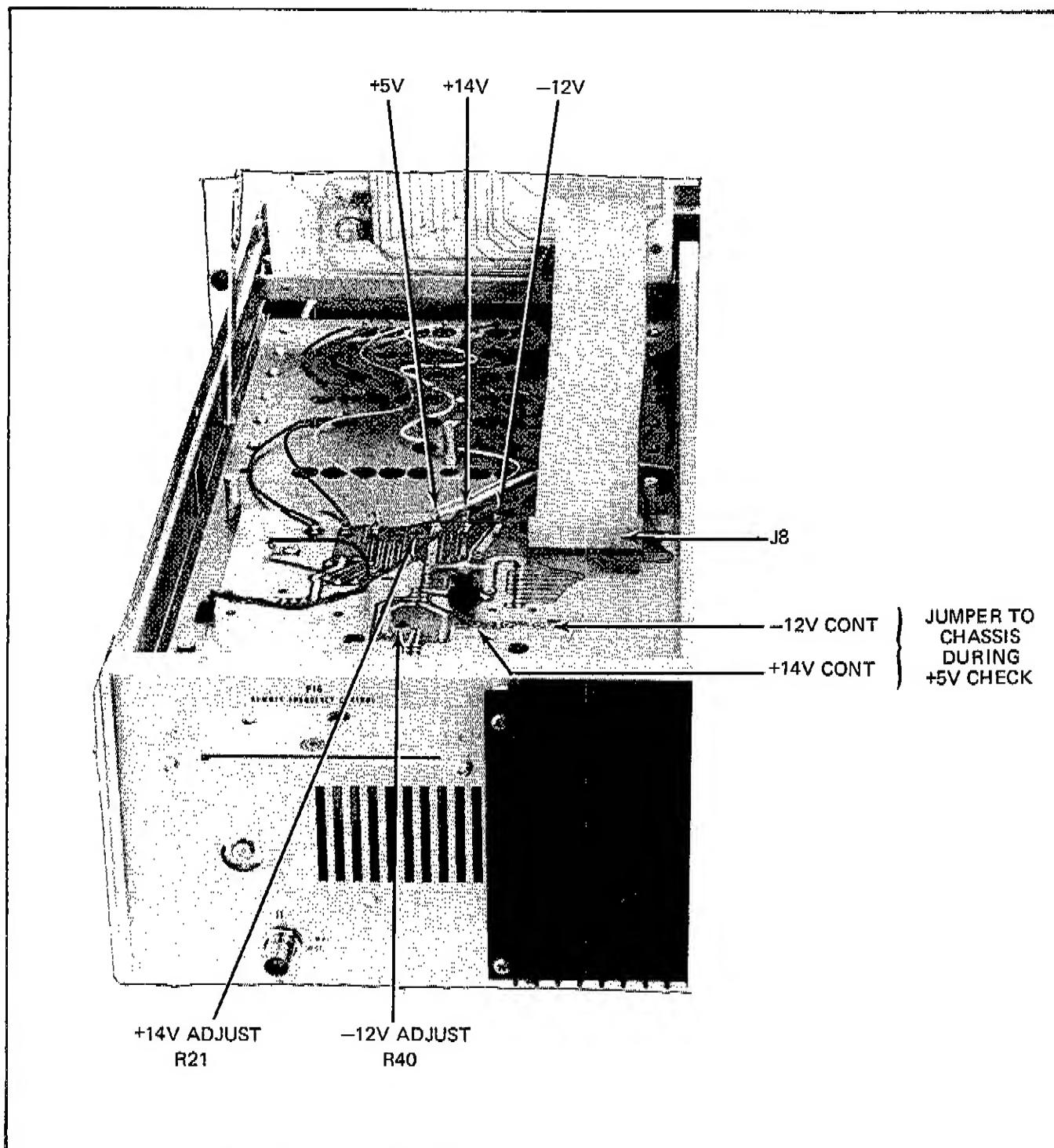


Figure 4-5. POWER SUPPLY REGULATOR ADJUSTMENT AND TEST POINT LOCATIONS

4-42. Input Filter (6160A-4101)

4-43. This module is removed from the synthesizer and aligned with the following equipment:

a. Power Supply

4-10

b. Oscilloscope

c. RF Voltmeter

d. 50 ohm load

e. Signal Generator (or internal standard if installed).

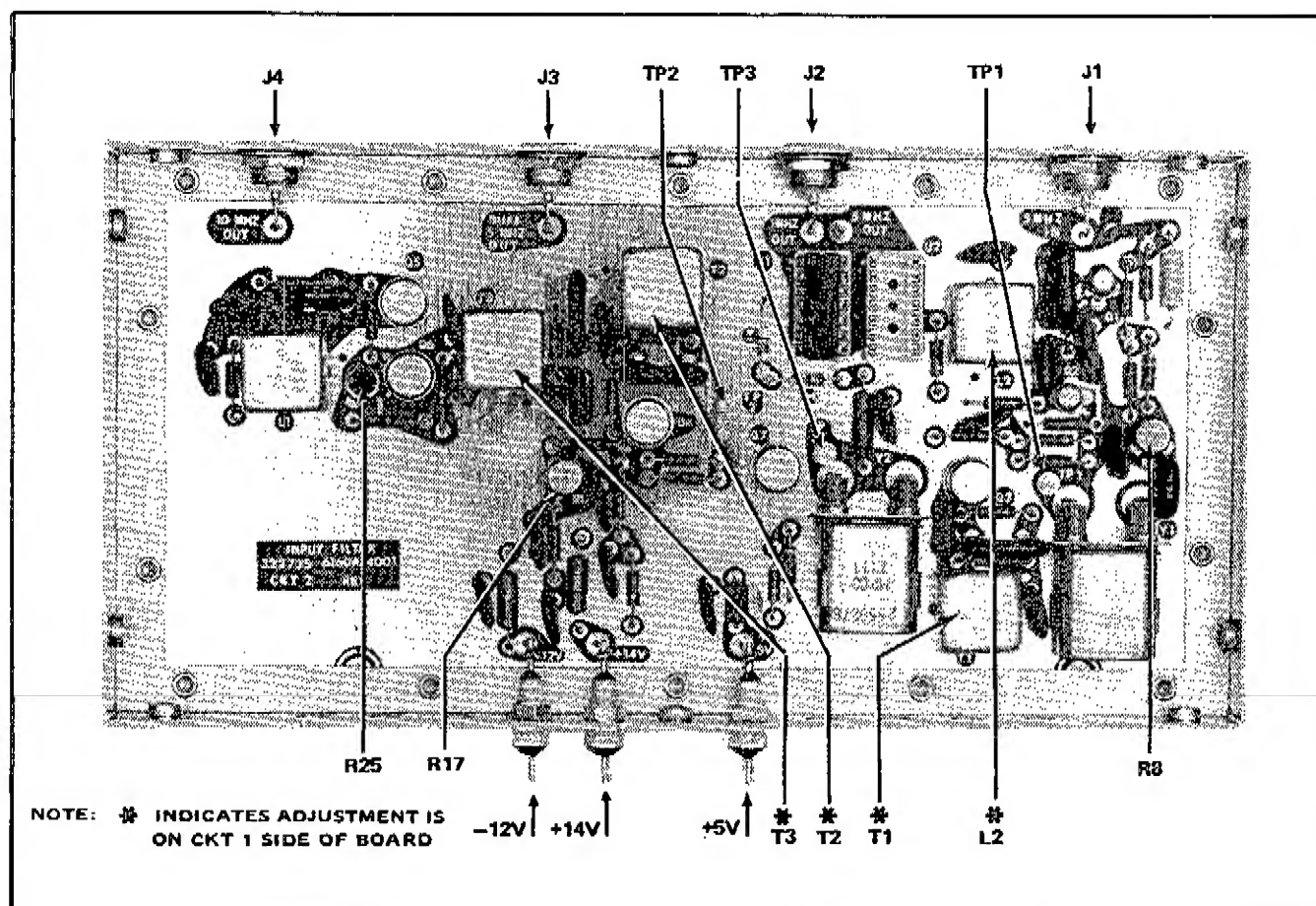


Figure 4-6. ADJUSTMENT, TEST POINT, AND INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4101)

4-44. Figure 4-6 shows adjustment, test point, and input/output connector locations on the Input Filter module. Alignment is as follows:

- a. Remove the cover from the module.
- b. Apply dc voltages (+5V, +14V, -12V) to appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.
- c. Apply a 5 MHz signal having a level of +7 dBm to J1.
- d. Connect the input of an oscilloscope (probe) to TP1 and its ground lead to TP2.
- e. Adjust L2 for maximum 5 MHz signal at TP1.
- f. Connect the oscilloscope input to TP3 and then adjust T1 and T3 for maximum 5 MHz signal.
- g. Connect the oscilloscope input together with a 50 ohm load to J4.
- h. Adjust L1, T1, and T3 for maximum 10 MHz signal at J4.
- i. Set the oscilloscope vertical sensitivity to 0.1 V/cm and adjust vertical centering until the upper peaks of the 10 MHz signal are at the center of the CRT.
- j. Adjust R25 until each cycle of the 10 MHz signal at J4 are equal in amplitude (minimum 5 MHz component).
- k. Adjust R8 for a 10 MHz peak-to-peak output of $1.1 \pm 0.1V$ at J4.
- l. Connect the input of an rf voltmeter together with a 50 ohm load to J3.
- m. Adjust T2 for maximum rms voltage at J3.
- n. Adjust R17 for a 1V rms output at J3.

- o. Connect the oscilloscope input to J2, observing that the 5 MHz TTL output has a peak-to-peak amplitude of 3.5V.
- p. Disconnect test equipment and replace module cover.

4-45. 1 MHz Digit Generator Module Set (6160B-4153)

4-46. The module set is aligned in two stages. First, the Step Loop (STP LP) module is aligned independently. Then the Main Loop Phase Detector (PH DET) and Main Loop (VCO) are aligned together with the Step Loop module. Prepare the module set for alignment as follows:

- a. Disconnect cables and wiring from module set and remove set from synthesizer.
- b. Remove module set joiners (2) and separate modules.

4-47. 1 MHZ STEP LOOP (6160B-4153-1)

4-48. Use the following test equipment for alignment of the Step Loop module.

- a. Power Supply (+14 V dc, +5 V dc and -12V dc)
- b. DVM
- c. Frequency Counter
- d. Spectrum Analyzer

4-49. Align the Step Loop (STP LP) module as follows:

- a. Remove module side covers.
- b. Connect dc supply voltage, 5 MHz TTL, and frequency counter (set for external standard mode) as shown in Figure 4-7.

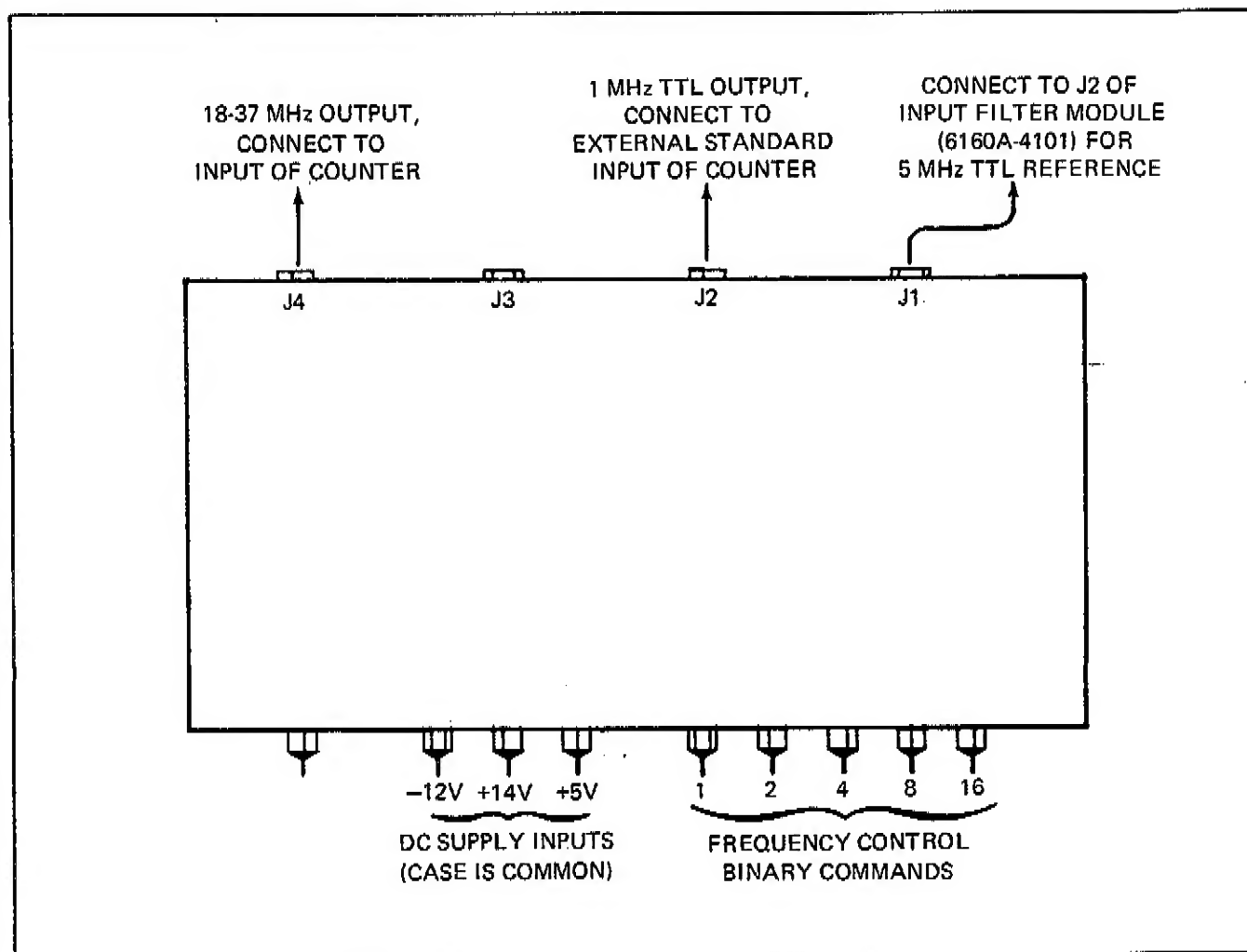


Figure 4-7. 1 MHz STEP LOOP EQUIPMENT CONNECTIONS.

Table 4-3. FREQUENCY CONTROL COMMANDS
1 MHz STEP LOOP

J4 OUTPUT	GROUNDING TERMINALS
18	16, 8, 4, 2, 1
19	16, 8, 4, 2
20	16, 8, 4, 1
21	16, 8, 4
22	16, 8, 2, 1
23	16, 8, 2
24	16, 8, 1
25	16, 8
26	16, 4, 2, 1
27	16, 4, 2
28	16, 4, 1
29	16, 4
30	16, 2, 1
31	16, 2
32	16, 1
33	16
34	8, 4, 2, 1
35	8, 4, 2
36	8, 4, 1
37	8, 4

- c. Program STP LP module for 18 MHz output at J4 by grounding appropriate feedthrough terminals (Figure 4-7) in accordance with Table 4-3.
- d. Connect DVM set for dc measurement to points indicated in Figure 4-8. Adjust L2 (See Figure 4-8 for location) for DVM indication within +1.49 Vdc to +1.51 Vdc.
- e. Disconnect DVM.
- f. Frequency counter should indicate 18 MHz.
- g. Program STP LP module for frequencies from 19 to 37 MHz in 1 MHz steps and observe corresponding frequencies of 19 to 37 MHz on frequency counter.

- h. Disconnect frequency counter and connect spectrum analyzer to J4 (18-37 MHz output).
- i. Program STP LP for 20 MHz output at J4 and center output signal on spectrum analyzer display.
- j. Program STP LP for 18 MHz and adjust C22 (See Figure 4-8 for location) for minimum upper 2 MHz sideband at center of display. (Spurious should be ≤ -90 db from fundamental).
- k. Program STP LP for 19 MHz output at J4.
- l. Adjust C19 (See Figure 4-8) for minimum upper 1 MHz sideband at center of display on spectrum analyzer. (Spurious should be ≤ -70 dB from fundamental).

- m. Disconnect all test equipment and power connections from module. Install module side cover.

4-50. 1 MHZ MAIN LOOP VCO (6160B-4153-2) AND MAIN LOOP PHASE DETECTOR (6160B-4153-3).

- 4-51. These modules are aligned using the following test equipment.

- a. Power Supply
- b. Signal Generator
- c. Frequency Counter
- d. Oscilloscope
- e. Previously aligned Step Loop module

- 4-52. Use the following procedure for aligning the Main Loop VCO and Phase Detector modules:

- a. Remove side covers from Main Loop VCO module (6160B-4153-2) and Main Loop Phase Detector (PH DET) Module, 6160B-4153-3.
- b. Interconnect modules as shown in Figure 4-9. Power supply inter-connection leads between VCO and PH DET modules should be long enough to allow access to adjustments within these two modules.
- c. Connect test equipment to terminals shown in Figure 4-9.

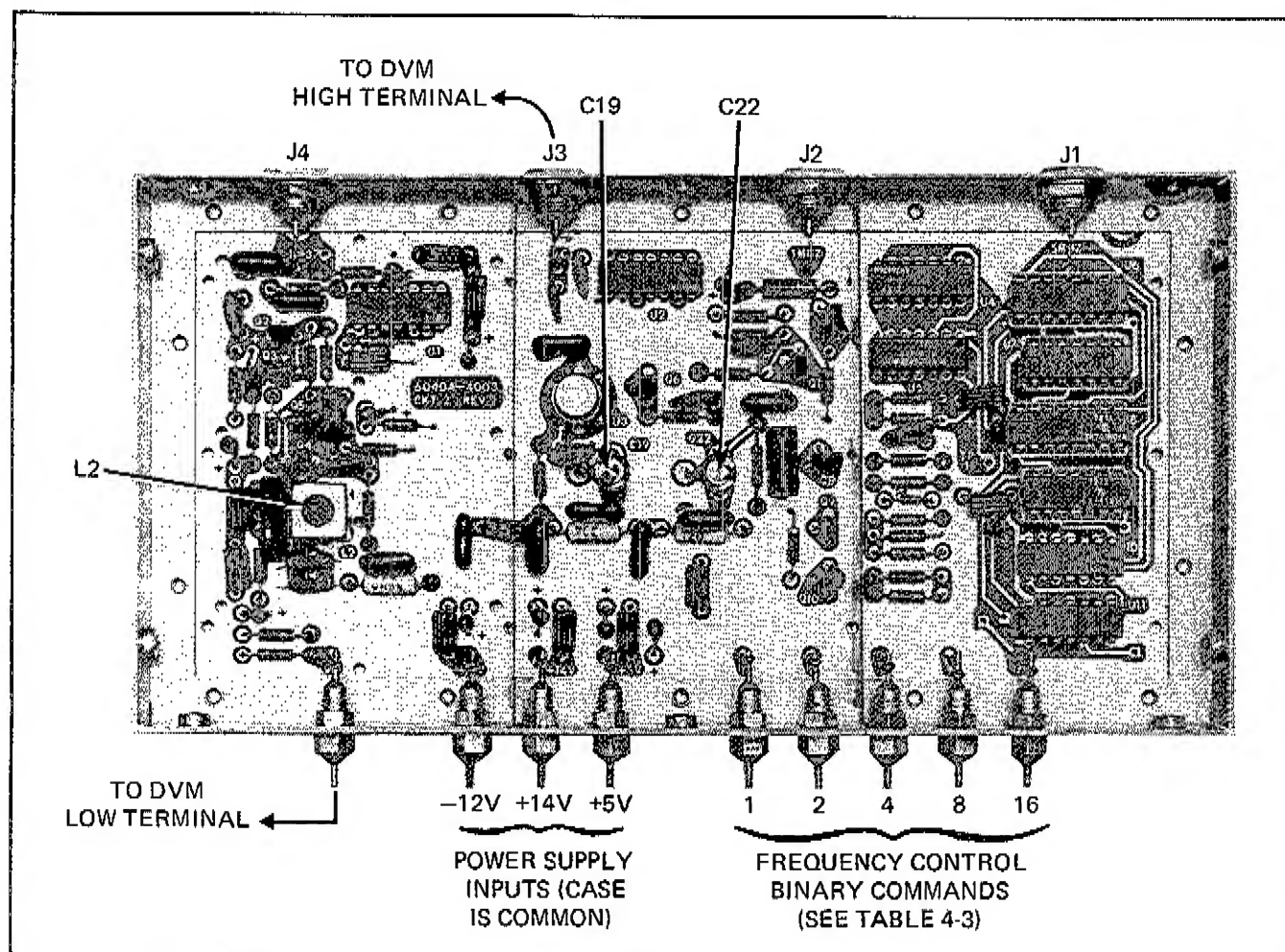
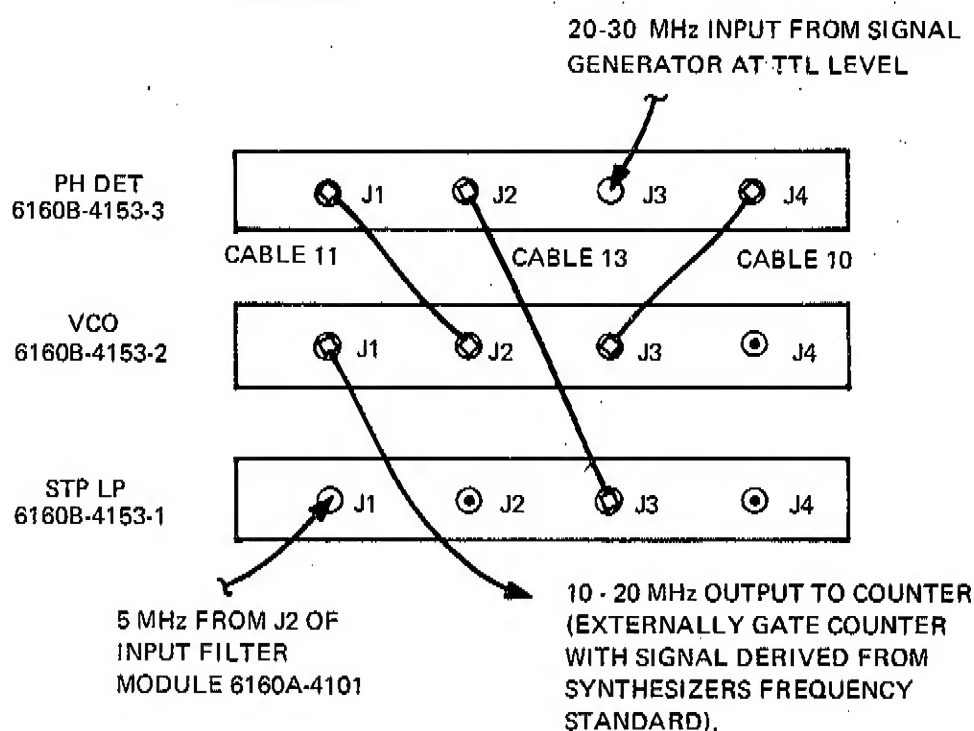


Figure 4-8. 1 MHz STEP LOOP (6160B-4153-1) ADJUSTMENT LOCATION AND DVM CONNECTION

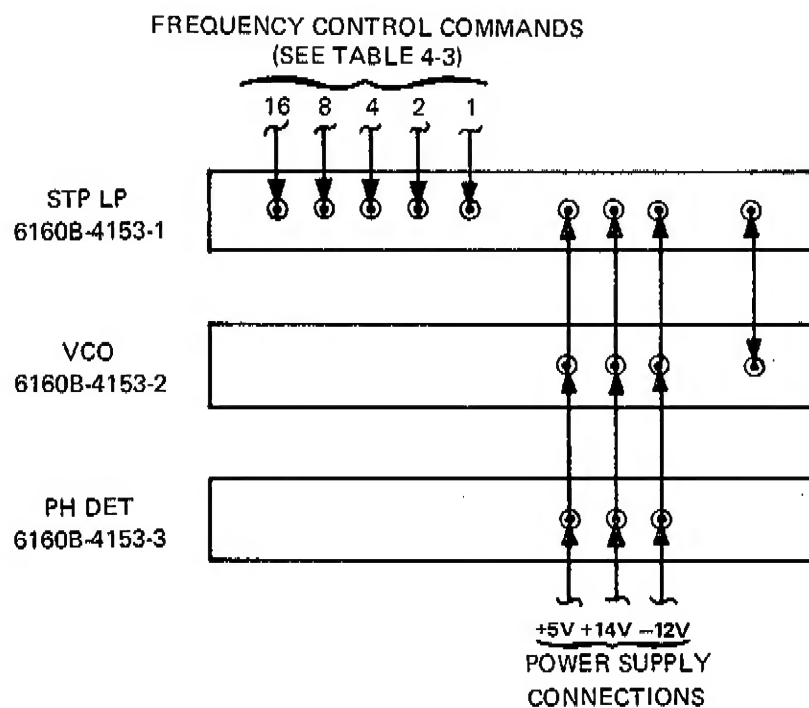
- d. Apply power to modules.
- e. Adjust signal generator, connected to J3 of PH DET, for 20 MHz output.
- f. Program STP LP module for 37 MHz, refer to Table 4-3.
- g. Adjust VCO inductor L8 for frequency counter display between 20.15 MHz and 20.25 MHz.
- h. Program STP LP for 18 MHz, refer to Table 4-3.
- i. Adjust PH DET potentiometer R5 for frequency counter indication between 10.65 MHz and 10.75 MHz.
- j. Re-check steps f through i and, if necessary, reset adjustment.
- k. Program STP LP from 19 to 36 MHz and observe that frequency counter indication is in accordance with Table 4-4.

Table 4-4. J1 VCO OUTPUT

PROGRAMMED FREQUENCY (MHz)	MAIN LOOP VCO OUTPUT J4 (MHz)	
	MIN	MAX
19	11.15	11.5
20	11.65	12.0
21	12.15	12.5
22	12.65	13.0
23	13.15	13.5
24	13.65	14.0
25	14.15	14.5
26	14.65	15.0
27	15.15	15.5
28	15.65	16.0
29	16.15	16.5
30	16.65	17.0
31	17.15	17.5
32	17.65	18.0
33	18.15	18.5
34	18.65	19.0
35	19.15	19.5
36	19.65	20.0



MODULE TOP VIEW



MODULE BOTTOM VIEW

Figure 4-9. 1 MHz DIGIT GENERATOR EQUIPMENT CONNECTIONS, No. 1

- l. Disconnect signal generator from J3 on PH DET and connect J4 of STP LP to J4 of VCO as shown in Figure 4-10
- q. Program STP LP, from 18 to 37 MHz and observe that amplitude of signal displayed on oscilloscope is greater than 80 mV p-p for all programmed frequencies from 18 to 37 MHz.

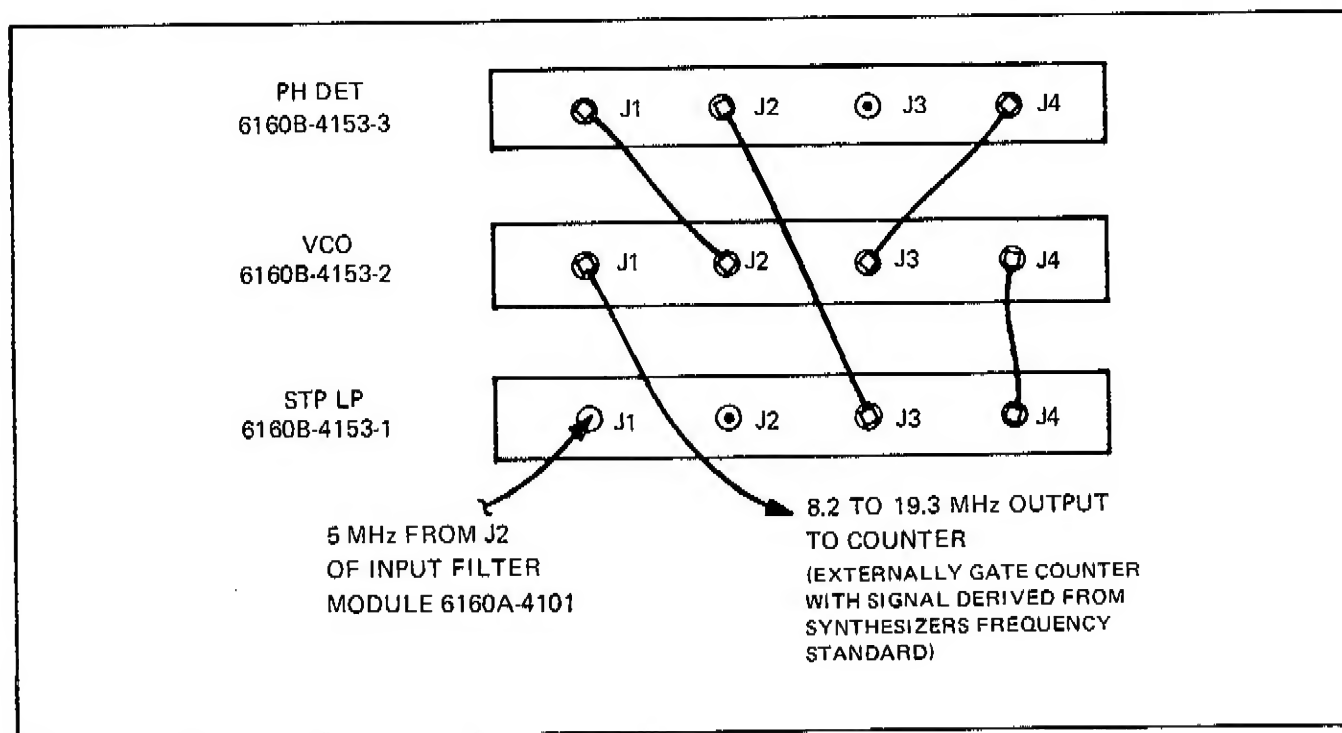


Figure 4-10. 1 MHz DIGIT GENERATOR EQUIPMENT CONNECTIONS, No. 2.

- m. Program STP LP from 18 to 37 MHz and observe on frequency counter that VCO output at J1 is in accordance with Table 4-5.

NOTE!

If VCO output does not meet limits specified in Table 4-5, VCO and PH DET modules must be retuned. If retuning is necessary, remove connection between STP LP module, J4, and VCO module, J4. Reconnect signal generator to J3 of PH DET module and repeat procedure beginning with Step e.

- n. Connect signal generator set to 20 MHz to J3 of PH DET module.
- o. Program STP LP module from 18 to 37 MHz and observe that frequency displayed on counter agrees with Table 4-6.
- p. Remove frequency counter and connect oscilloscope to J4 from inside of VCO module.

Table 4-5. J1 VCO OUTPUT (J4 VCO TO J4 STP LP)

PROGRAMMED STEP LOOP FREQUENCY (MHz)	MAIN LOOP VCO OUTPUT J1 (MHz)	
	MIN	MAX
18	8.2	9.8
19	8.7	10.3
20	9.2	10.8
21	9.7	11.3
22	10.2	11.8
23	10.7	12.3
24	11.2	12.8
25	11.7	13.3
26	12.2	13.8
27	12.7	14.3
28	13.2	14.8
29	13.7	15.3
30	14.2	15.8
31	14.7	16.3
32	15.2	16.8
33	15.7	17.3
34	16.2	17.8
35	16.7	18.3
36	17.2	18.8
37	17.7	19.3

Table 4-6. VCO OUTPUT CHECK

PROGRAMMED FREQUENCY MHz	VCO OUTPUT J1
18	10.0
19	10.5
20	11.0
21	11.5
22	12.0
23	12.5
24	13.0
25	13.5
26	14.0
27	14.5
28	15.0
29	15.5
30	16.0
31	16.5
32	17.0
33	17.5
34	18.0
35	18.5
36	19.0
37	19.5

NOTE: Stability of J1 output depends upon stability of signal generator used.

- r. Remove all test equipment and module interconnections.
- s. Attach module side covers.
- t. Refer to Figure 4-11 and assemble module set in order shown. Attach module set joiners (2).
- u. Secure module set to synthesizer. Connect numbered cables in accordance with Figure 4-11. Connect wiring in accordance with Figure 4-3.

4-53. Six Digit Generator (6040A-4102)

4-54. This module is aligned within the synthesizer (See Figure 4-1 for location). Tilt the hinged assembly up after removing the four screws securing the module to the synthesizer. Remove the module cover to expose the pcb and adjustments. Adjustment and test point locations are illustrated in Figure 4-12. Use the following test equipment to align this module.

- a. DVM.
- b. Oscilloscope.
- c. Frequency Counter.

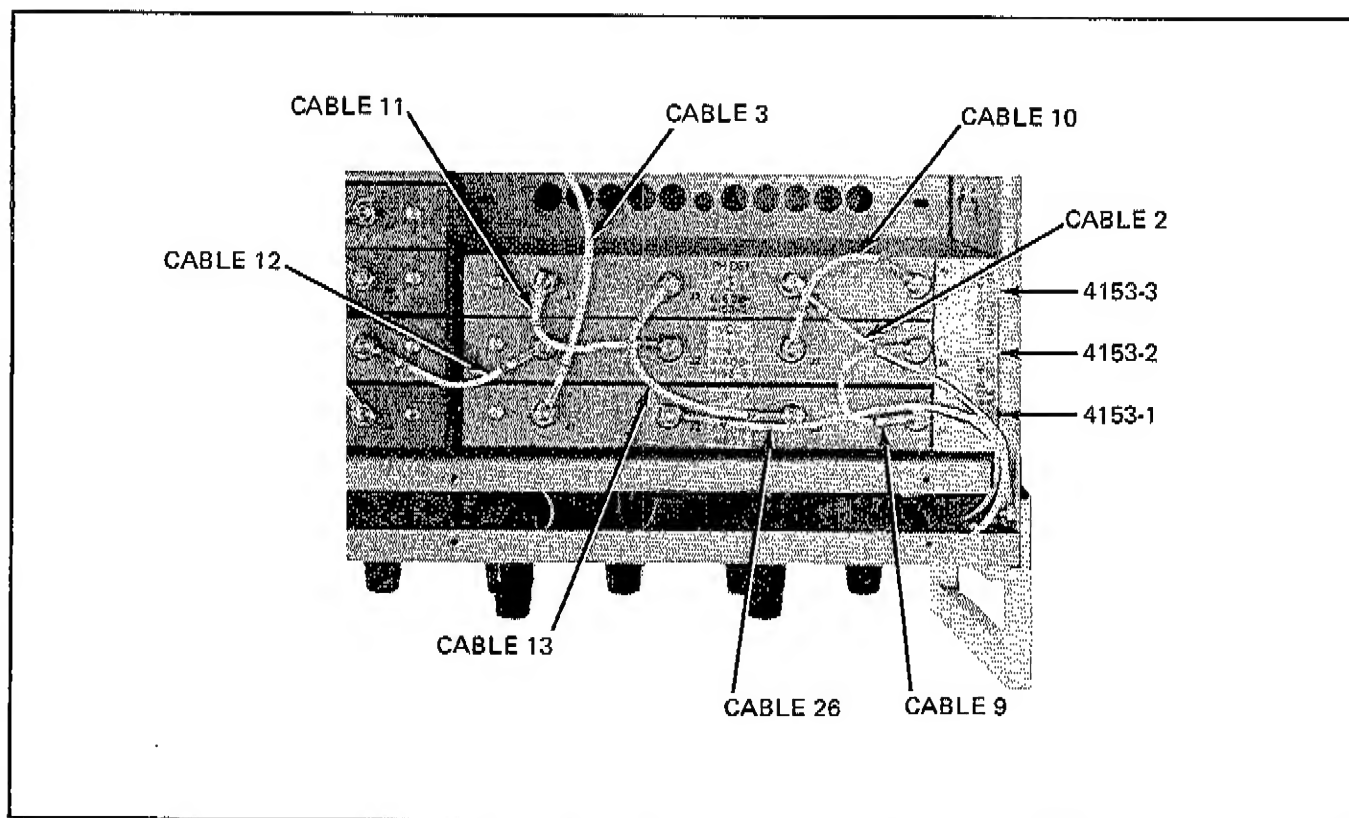


Figure 4-11. 1 MHz MODULE SET CABLING CONNECTIONS

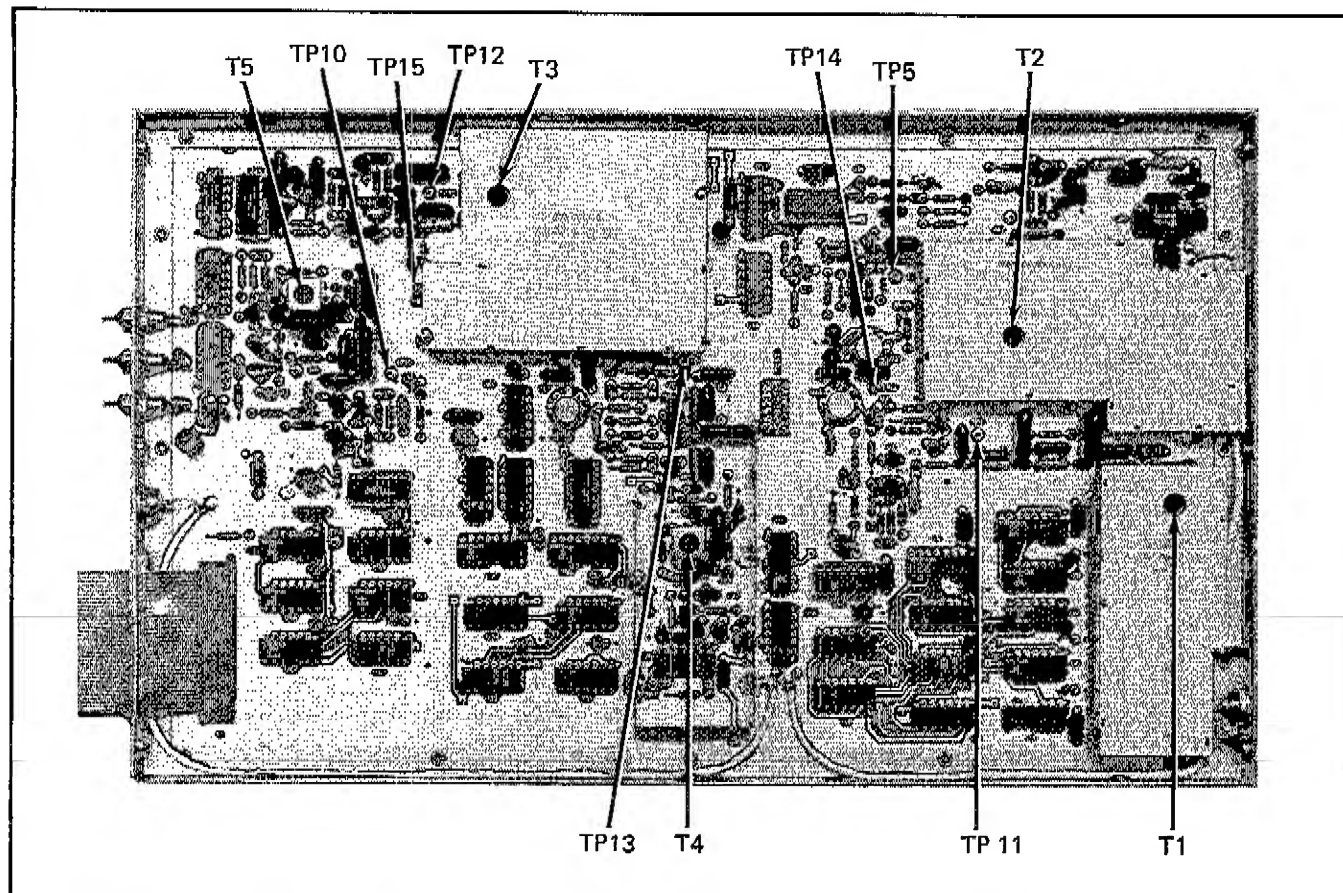


Figure 4-12. SIX DIGIT GENERATOR ADJUSTMENTS AND TEST POINTS

- d. DVM Input Filter (1000 pf $\pm 5\%$ capacitor, across DVM input terminals and 10 k Ω $\pm 1\%$ resistor in series with HI input lead to DVM).
- 4-55. 10 HZ STEP LOOP
- a. Connect DVM set for dc measurement, through input filter to TP 10 (+) and ground (module frame). Set FUNCTION switch to 10-160 MHz and dial 80.000000 MHz.
 - b. Adjust T5 for +3.5 Vdc ± 0.1 Vdc indication on DVM.
 - c. Dial 80.000049 MHz and observe that DVM indication is greater than +1.9V.
- 4-56. 1 KHZ STEP LOOP
- a. Connect DVM through filter to TP13 (+) and ground. Dial 80.004950 MHz.
 - b. Adjust T4 for +2.5 Vdc ± 0.1 Vdc indication on DVM.
 - c. Dial 80.000000 MHz and observe DVM indication between +5.0 and +6.2 Vdc.
- 4-57. 100 KHZ STEP LOOP
- a. Connect DVM through filter to TP11 (+) and ground. Dial 80.000000 MHz.
 - b. Adjust T1 for 2.5 Vdc ± 0.1 Vdc indication on DVM.
 - c. Dial 80.495000 MHz and observe DVM indication between +7.4 to +8.6 Vdc.

4-58. 1 KHZ MAIN LOOP

- a. Connect DVM low input, through filter, to TP15 and high input to TP12. Dial 80.000049 MHz.
- b. Adjust T3 for 0 Vdc within the limits of 0 Vdc to +0.05 Vdc.
- c. Vary the 1, 10, 100, 1000 Hz frequency dials throughout their ranges noting the maximum and minimum DVM indications. The minimum indication should be between 0V and +0.5 Vdc and the maximum indication should be less than +0.38 Vdc.
- d. If minimum indication occurs at dial setting other than 80.000049 MHz, repeat step b at frequency of minimum voltage.
- e. Repeat step c.

NOTE!

A maximum indication greater than +0.38 indicates the varactor diodes, CR10 and CR7, are not tracking properly and should be replaced.

4-59. 100 KHZ MAIN LOOP

- a. Connect low input of DVM, through filter, to TP14 and high input to TP5. Dial 80.999999 MHz.
- b. Adjust T2 for -0.17 Vdc within the limits of -0.15 Vdc to -0.20 Vdc.
- c. Set the 1 and 10 Hz dials to 49 and vary the 100 Hz, 1 kHz, 10 kHz, and 100 kHz dials throughout their ranges. Note the maximum and minimum indications on the DVM. The maximum indication should be more negative than -0.15 Vdc and the minimum indication more positive than -0.50 Vdc.
- d. If maximum indication is more positive than -0.15V, repeat step b at frequency of maximum voltage.
- e. Repeat step c.

NOTE

Any adjustment of T1, T2, T3 or T4, or related circuitry, will necessitate the repeating of procedures 4-58 and 4-59.

NOTE!

A minimum voltage more negative than -0.50 Vdc indicates that varactor diodes CR1 and CR2 are not tracking properly and should be replaced.

4-60. SYNTHESIS CHECK

- a. Connect frequency counter to J2 of module and perform first ten steps of Table 4-16.
- b. Remove DVM and frequency counter.
- c. Install cover on module. Tilt module assembly down into synthesizer and secure with four screws.

4-61. 10 MHz. Main Loop Phase Detector (6160A-4109)

4-62. This module is removed from the synthesizer and aligned with the following equipment.

- a. Power Supply.
- b. Signal Generator (2).
- c. Oscilloscope.
- d. 6 db Splitter.
- e. 10 db Attenuator.
- f. Digital Voltmeter.
- g. 50 ohm load.

4-63. Figure 4-13 shows adjustment test point, and input output connector locations on the 10 MHz D.U. Main P.D. module. Alignment is as follows:

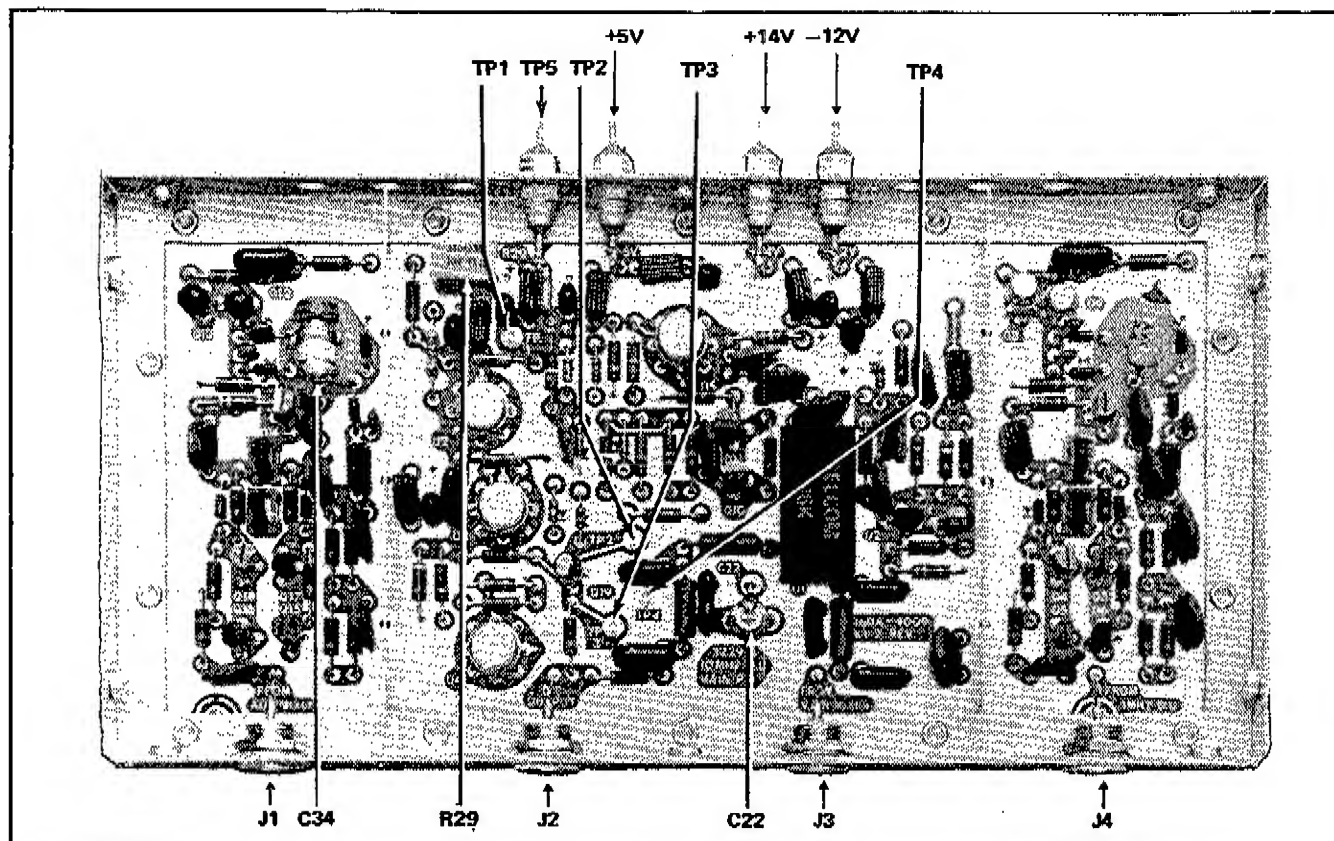


Figure 4-13. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4109)

- a. Remove the cover from module.
- b. Apply dc voltages (+5V, +14V, -12V) to the appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.
- c. Connect the input of an oscilloscope to J2. Set the oscilloscope to dc input and establish a 0V reference.
- d. Connect a 50 ohm load to J3 and connect a shorting jumper between -12V input and TP5 feed-thru connector.
- e. Adjust R29 for 0V dc at J2.
- f. Make the test equipment connections shown in Figure 4-14.
- g. Set signal generator No. 1 to 15 MHz and connect A output to J1 and B output to J4.
- h. Adjust C34 for 0 Vdc at J2.

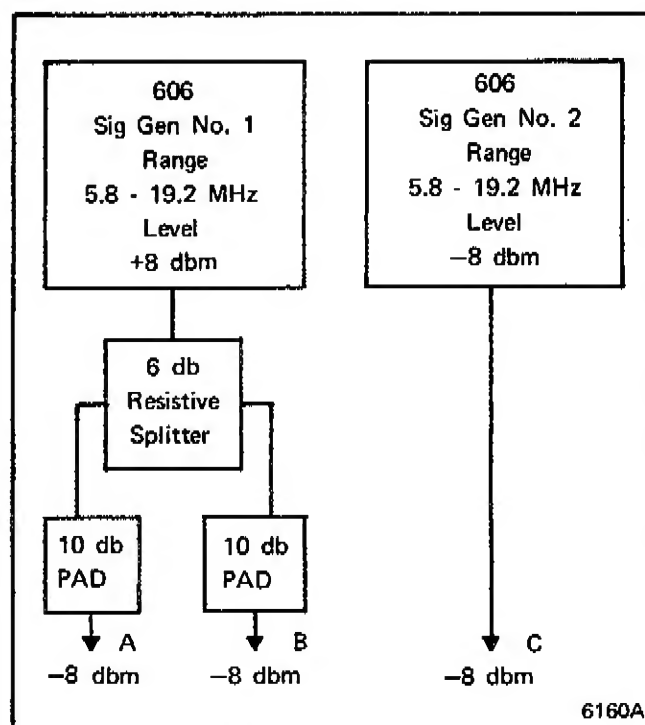


Figure 4-14. EQUIPMENT CONNECTION FOR 10 MHz D. U. MAIN PD TEST

- i. Tune signal generator No. 1 from 10 to 19 MHz, observing that the dc voltage at J2 does not change more than +4 mV. If necessary, adjust C34 to satisfy this requirement.
 - j. Set signal generator No. 1 to 15 MHz and adjust R29 for 0 Vdc at J2.
 - k. Disconnect 50 ohm load from J3 and connect the output (C) of signal generator No. 2 to J3.
 - l. Set signal generator No. 1 to 10 MHz and signal generator No. 2 to 20 MHz. Also disconnect
 - m. Connect a shorting jumper between TP2 and TP4 and adjust C22 for a minimum amplitude (less than 40 mV peak-to-peak) 10 MHz signal at J2.
 - n. Set signal generator No. 1 to 15 MHz and No. 2 to 16 MHz, observing that the 1 MHz signal at J2 has a peak-to-peak amplitude of 40 mV. Offset should be less than +2 mVdc.
 - o. Disconnect shorting jumper between TP2 and TP4.
 - p. Connect digital voltmeter to TP2 (+) and TP4 (-).
 - q. Tune signal generator No. 2 from 12 MHz to 18 MHz, observing that the voltage at TP2 is -10.7 ± 0.7 Vdc, except when signal generator frequency is 15 ± 0.02 MHz. At 15 ± 0.02 MHz the voltage at TP2 should be 0 ± 50 mV.
 - r. Disconnect signal generator No. 1 output (B) from J4 and signal generator No. 2 output (C) from J3.
 - s. Connect signal generator No. 2 output (C) to J4 and tune it slowly down from 15 MHz. The voltage at J2 should decrease from 0 ± 2 mV to -22 ± 5 mV at a signal generator No. 2 frequency of 14.2. to 13.8 MHz.
 - t. Slowly increase signal generator No. 2 frequency, observing that the voltage at J2 increases from 0 +2 mV to $+22 \pm 5$ mV at a signal generator frequency of 15.8 to 16.2 MHz.
 - u. Connect a shorting jumper between -12V and TP5 feed-thru connector.
 - v. Connect digital voltmeter to TP3 (+) and TP4 (-).
 - w. Tune signal generator No. 2 until the voltage at TP3 is 1 ± 0.05 Vdc.
 - x. Connect a shorting jumper between TP2 and TP4, observing that the voltage at TP3 is 0 ± 35 mV.
 - z. Disconnect test equipment and replace module cover.
- 4-64. 10 MHz Step Loop Phase Detector (6160A-4106-1)**
- 4-65. This module is removed from the synthesizer and aligned with the following equipment:
- a. Power Supply.
 - b. Oscilloscope
 - c. Signal Generator (2).
 - d. Digital Voltmeter.
 - e. 50 ohm Load
 - f. 6.8k, $\frac{1}{4}$ W Resistor
 - g. 12k, $\frac{1}{4}$ W Resistor.
- 4-66. Figure 4-15 shows adjustment, test point, and input/output connector locations on the 10 MHz D. U. Step Loop P. D. module. Alignment is as follows:
- a. Remove the cover from the module.
 - b. Connect the input of an oscilloscope (probe) to TP4 and its ground lead to TP3.
 - c. Apply a 10 MHz signal having a level of +13 dbm +2 db to J2.
 - d. Adjust C13 for minimum amplitude 10 MHz signal (less than 70 mV peak-to-peak at TP4).
 - e. Disconnect the oscilloscope and signal generator from the module.
 - f. Apply dc voltages (+5V, +14V, -12V) to appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.
 - g. Apply +5V to "4" feed-thru connector.

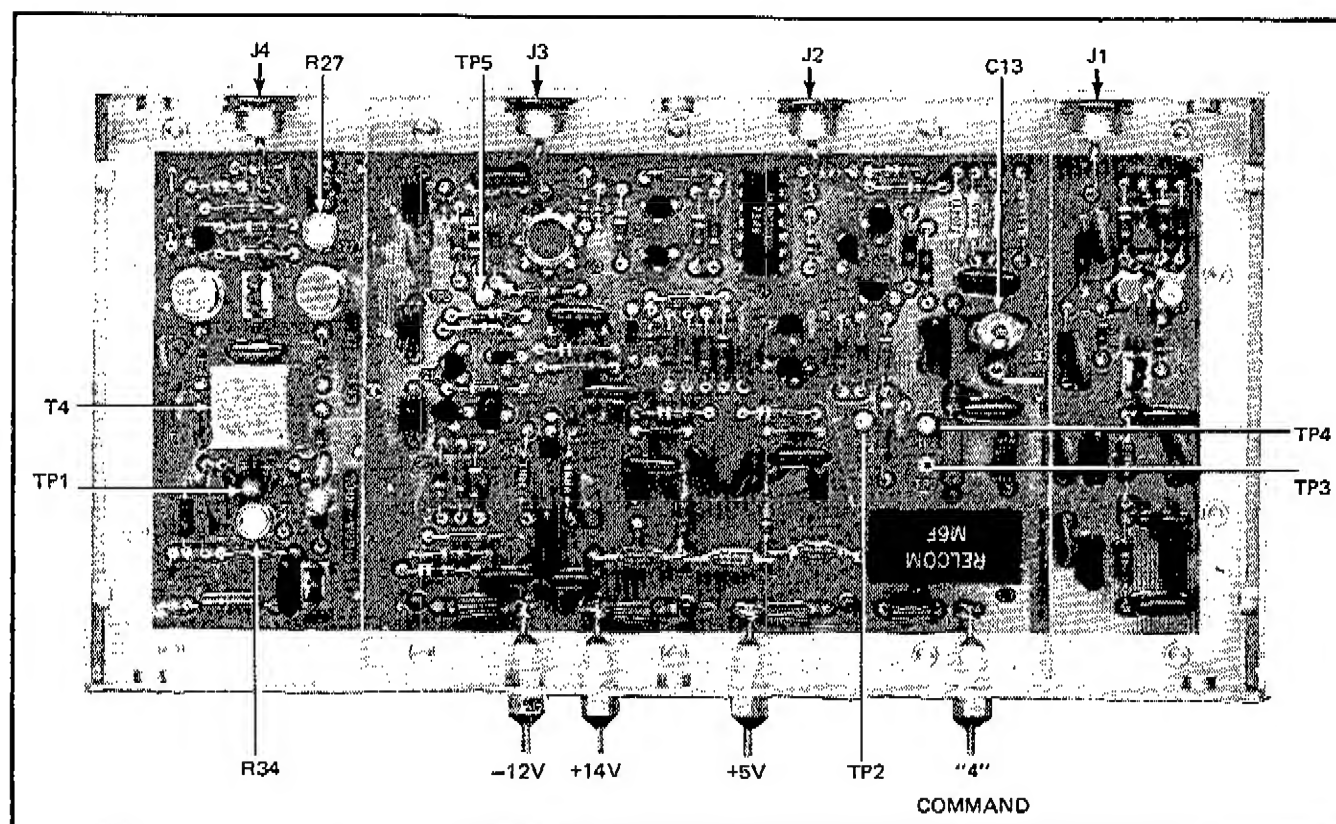


Figure 4-15. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4106-1)

- h. Apply a 140 MHz signal having a level of +5 dbm ± 2 db to J1.
- i. Connect a digital voltmeter together with a 50 ohm load to J2, observing that the dc voltage is 0 ± 0.6 mV. Disconnect the digital voltmeter upon completion of this step.
- j. Apply a 10 MHz signal having an amplitude of +7 dbm ± 2 db to J4.
- k. Connect the input of an oscilloscope (probe) to TP1 and its ground lead to TP3.
- l. Adjust T4 for maximum amplitude 10 MHz signal at TP1.
- m. Adjust R27 for a 10 MHz signal having a peak-to-peak amplitude of 3V at TP1.
- n. Adjust R34 until the notch in the 10 MHz waveform is slightly above the center point (zero crossing).
- o. Repeat step 1, and n. until results are obtained without further adjustment.
- p. Connect the input of the oscilloscope together with a 50 ohm load to J2.
- q. Connect a shorting jumper between TP2 and TP3. Also disconnect +5V from "4" feed-thru and then ground the feed-thru.
- r. Apply a 71 MHz signal having a level of +5 dbm ± 2 db to J1.
- s. Adjust R27 for a 1 MHz beat signal at J2 which has a peak-to-peak amplitude of 60 ± 5 mV.
- t. Perform the checks in Table 4-7, observing that the 1 MHz beat signal at J2 has a peak-to-peak amplitude of 35 to 60 mV.

Table 4-7. BEAT SIGNAL CHECKS

J1 FREQ (MHz)	"4" FEED-THRU
71	GND
81	GND
91	GND
101	GND
111	+5V
121	+5V
131	+5V
141	+5V

- u. Disconnect the shorting jumper from TP2.
- v. Apply a 141 MHz signal having a level of +5 dbm ± 2 db to J1. Also ensure that the "4" feed-thru connector has +5V applied.
- w. Connect a digital voltmeter to TP5 (+) and TP3 (-), observing that the voltage at TP5 is +2 to +3 Vdc.
- x. Establish a 0V reference (dc coupled input) on the oscilloscope connected to J2.
- y. Apply -12 Vdc via a 6.8k, $\frac{1}{4}$ W resistor to J3, observing that the peaks of the output signal at J2 shift -10 ± 2 mVdc.
- z. Apply +14 Vdc via a 12k, $\frac{1}{4}$ W resistor to J3, observing that the peaks of the input signal at J2 shift $+10 \pm 2$ mVdc.
- aa. Disconnect test equipment and replace module cover.
- a. Power Supply (2).
- b. Frequency Counter.
- c. Digital Voltmeter.
- d. RF Voltmeter.
- e. Signal Generator.
- f. 50 ohm load.
- g. 1k ohm load.
- h. 33k, $\frac{1}{4}$ W Resistor.
- i. 39k, $\frac{1}{4}$ W Resistor.
- j. 3M, $\frac{1}{4}$ W Resistor
- k. 3.3M, $\frac{1}{4}$ W Resistor.
- l. 130 Ω , $\frac{1}{4}$ W Resistor.

4-67. 10 MHz Step Loop VCO (6160A-4107-1)

4-68. This module is removed from the synthesizer and aligned with the following equipment:

4-69. Figure 4-16 shows adjustment, test point, and input/output connector locations on the 10 MHz Step Loop VCO module. Alignment is as follows:

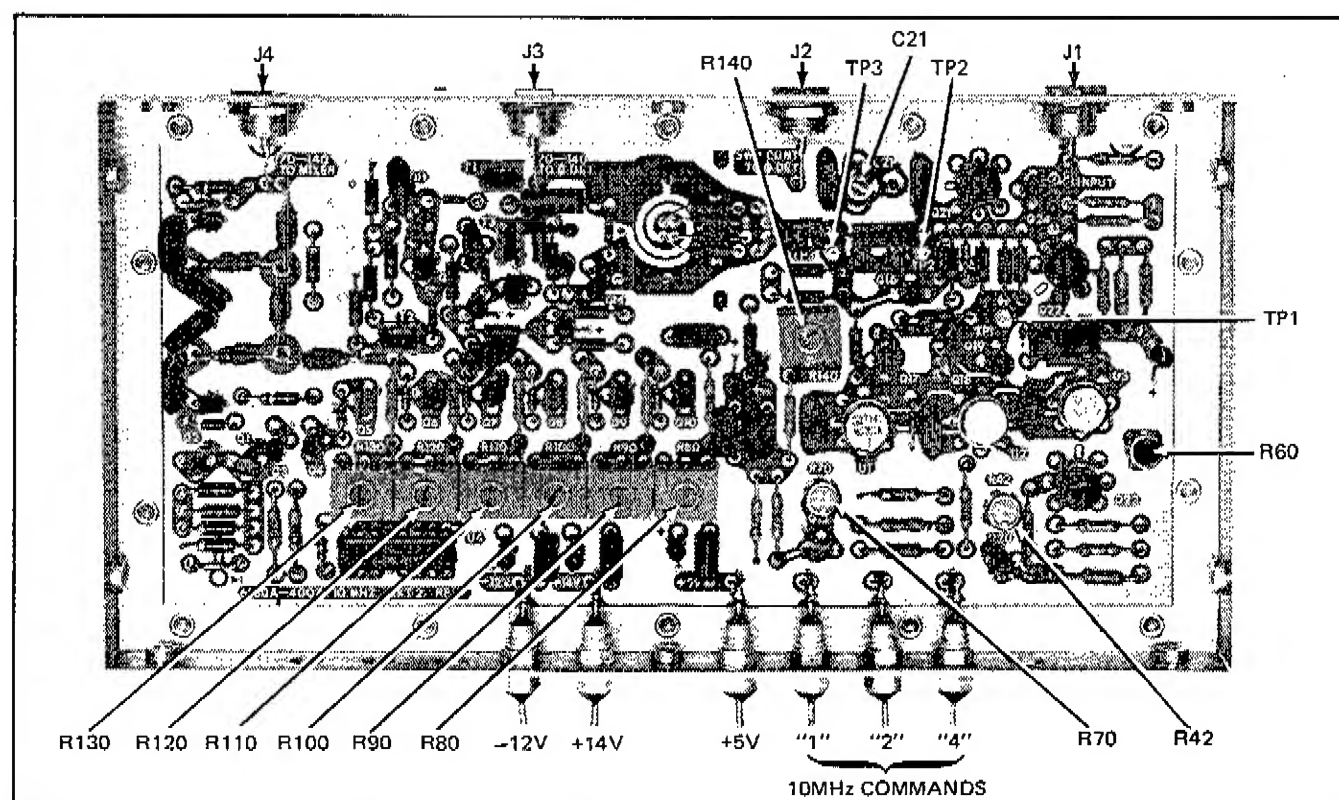


Figure 4-16. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4107-1)

- | | | | |
|----|---|-----|---|
| a. | Remove the cover from the module. | q. | Apply +14 Vdc via a 39k, ¼W resistor to J1 and record the frequency counter indication. |
| b. | Apply dc voltages (+5V, +14V, -12V) to appropriate feed-thru connectors on the module. Connect power supply common to the module chassis. | r. | Repeat steps p and q and adjust R70 until same frequency counter indication is observed in both steps. |
| c. | Apply -12 Vdc via a 33k, ¼W resistor to J1. Also connect a 130Ω, ¼W resistor from J1 to ground. | s. | Disconnect jumpers from "4", "2", "1" feed-thru connectors. |
| d. | Connect a digital voltmeter to TP1 (+) and the module chassis (-). | t. | Repeat steps p and q and adjust R140 until the same frequency counter indication is observed in both steps. |
| e. | Jumper the "4", "2", "1" feed-thru connectors to ground (one at a time) until the voltage at TP1 is nearly 8V, but less than 8V. | u. | Jumper only "4", "2" feed-thru connectors to ground. |
| f. | Disconnect the input voltage of J1 and then adjust R60 until a point is found where adjustment either direction causes the voltage at TP1 to increase or decrease a few hundred mV. | v. | Repeat steps p and q and adjust R80 until the same frequency is observed in both steps. |
| g. | Apply -12 Vdc via a 3M, ¼W resistor to J1, observing that the voltage at TP1 decreases the same amount as in step f. | w. | Jumper only "4", "1" feed-thru connectors to ground. |
| h. | Apply +14V via a 3.3M, ¼W resistor to J1, observing that the voltage at TP1 increases the same amount as in step f. | x. | Repeat steps p and q, and adjust R90 until the same frequency is observed in both steps. |
| i. | Repeat steps f, thru h. until all results are obtained without further adjustment. | y. | Jumper only "4" feed-thru connector to ground. |
| j. | Connect the input of a frequency counter to J4. | z. | Repeat steps p and q, and adjust R100 until the same frequency is observed in both steps. |
| k. | Jumper only the "2", "1" feed-thru connectors to ground. | aa. | Jumper only "2", "1" feed-thru connectors to ground. |
| l. | Apply -12 Vdc via a 33k, ¼W resistor to J1 and adjust R110 and R140 for a 7 MHz indication on the frequency counter. | ab. | Repeat steps p and q, and adjust R110 until the same frequency is observed in both steps. |
| m. | Apply +14 Vdc via a 39k, ¼W resistor to J1. | ac. | Jumper only "2" feed-thru connector to ground. |
| n. | Adjust R42 for a 3 MHz indication on the frequency counter. | ad. | Repeat steps p and q and adjust R120 until the same frequency is observed in both steps. |
| o. | Jumper the "4", "2", "1" feed-thru connectors to ground. | ae. | Jumper only "1" feed-thru connector to ground. |
| p. | Apply 12 Vdc via a 33k, ¼W resistor to J1 and record the frequency counter indication. | af. | Repeat steps p and q and adjust R130 until the same frequency is observed in both steps. |
| | | ag. | Jumper the "4", "2", "1" feed-thru connectors to ground and apply -12 Vdc via a 33k, ¼W resistor to J1. |

- ah. Observed that the voltage at TP1 is at least +1 Vdc. If not, lengthen two loops of wire (No. 1, No. 2) until there is a +1 Vdc at TP1.
- ai. Disconnect the jumpers from the "4", "2", "1" feed-thru connectors, observing that the voltage at TP1 is less than +11.4 Vdc.
- aj. Apply +14 Vdc via a 39k, 1/4W resistor to J1, observing that the voltage at TP1 is less than +12.2 Vdc.
- ak. Disconnect +5V, +14V, -12V input power to the module and connect the input of an rf voltmeter to TP3.
- al. Apply a 10 MHz signal having a level of 1V rms to TP3 and adjust C21 for maximum rms voltage at TP3.
- am. Disconnect rf voltmeter and 10 MHz signal.
- an. Apply dc voltages (+5V, +14V, -12V) to the appropriate feed-thru connectors. Connect power supply common to the module chassis.
- ao. Connect an rf voltmeter together with a 50 ohm load to J3.
- ap. Apply -12 Vdc via a 33k, 1/4W resistor to J1 and perform output checks in Table 4-8.
- ar. Connect rf voltmeter together with 50 ohm load to J4.
- as. Repeat steps ap, and aq., observing that a 1.5 \pm 1 dbm output is present at J4.
- at. Connect the digital voltmeter together with a 1k ohm load to J2.
- au. Apply -12 Vdc via a 33k, 1/4W resistor to J1, observing that the output voltage at J2 is +1.1 \pm 0.1 Vdc.
- av. Apply +14 Vdc via a 39k, 1/4W resistor to J1, observing that the output voltage at J2 is -1.5 \pm 0.1 Vdc.
- aw. Disconnect test equipment and replace module cover.

4-70. 10 MHz I.F. Mixer (6160A-4108)

4-71. This module is removed from the synthesizer and aligned with the following equipment:

- Power Supply
- Signal Generator (2).
- RF Voltmeter (with rf probe).
- 50 ohm load (2).

4-72. Figure 4-17 shows adjustment, test point, and input/output connector locations on the 10 MHz D.U.I.F. Mixer module. Alignment is as follows:

- Remove the cover from the module.
- Apply dc voltages (+5V, +14V, -12V) to the appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.
- Apply 1 115 MHz signal having a level of +5 dbm \pm 2 db to J1.
- Apply a 100 MHz signal having a level of +1 dbm \pm 0.5 db to J2.

Table 4-8. 70MHz THRU 100MHz OUTPUT CHECKS

STEP	GROUNDING TERMINAL	J3 OUTPUT LEVEL
1	4, 2, 1	} 3 \pm 2dbm
2	4, 2	
3	4, 1	
4	4	

- aq. Apply +14 Vdc via a 39k, 1/4W resistor to J1 and perform the output checks in Table 4-9.

Table 4-9. 110MHz THRU 140MHz OUTPUT CHECKS

STEP	GROUNDING TERMINAL	J3 OUTPUT LEVEL
1	2, 1	} 3 \pm 2dbm
2	2	
3	1	
4	NONE	

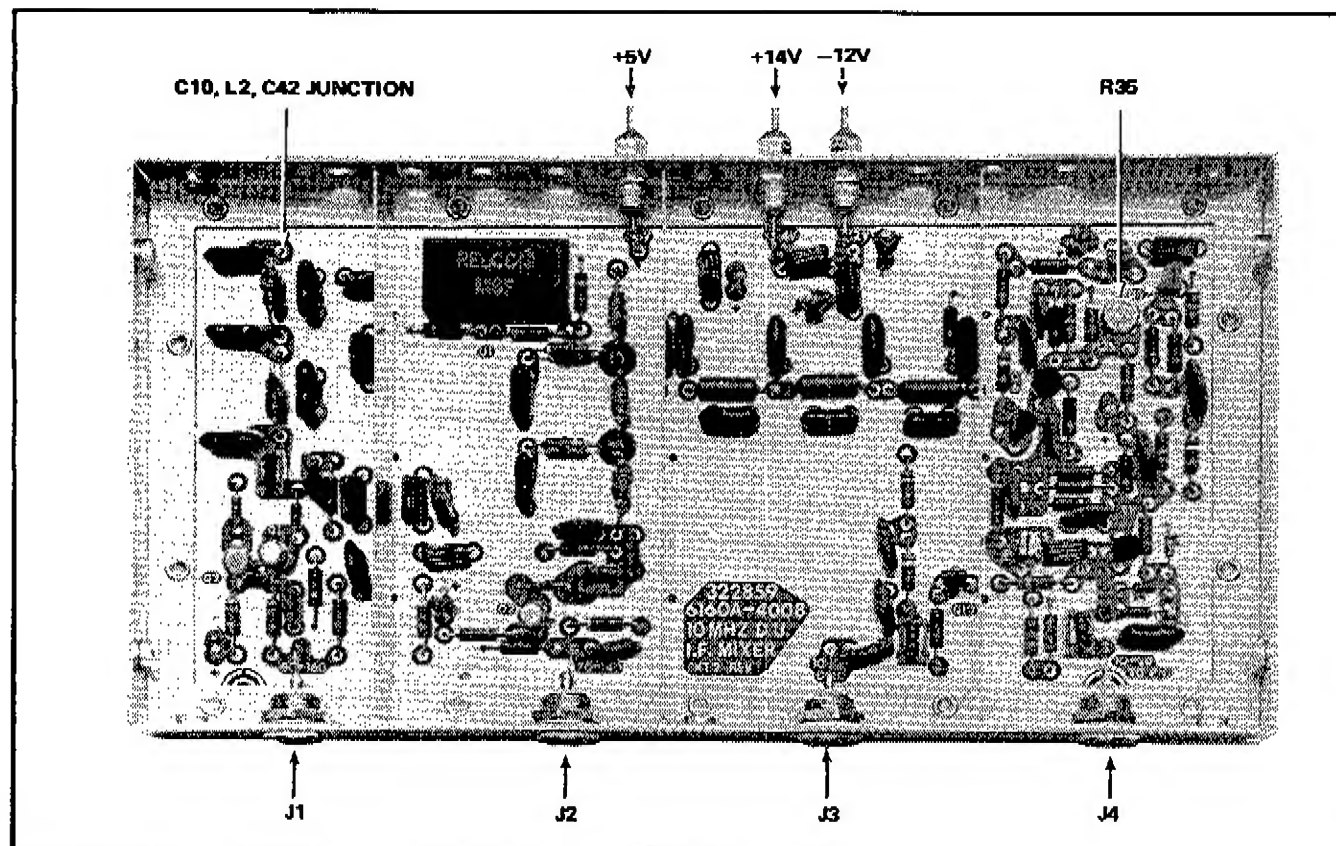


Figure 4-17. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4108)

- e. Connect a 50 ohm load to J3.

Table 4-10. OUTPUT LEVEL CHECKS

- f. Connect the input of an rf voltmeter together with a 50 ohm load to J4.

J1		J2		J4 OUTPUT
FREQ (MHz)	LEVEL (dbm)	FREQ (MHz)	LEVEL (dbm)	LEVEL (dbm)
150	+5±2	140	-9±0.5	> -14.5
160	+5±2	140	-8±0.5	> -14.5
172	+5±2	140	+1±0.5	> -20
157	+5±2	120	+1±0.5	< -40

- g. Adjust R35 for a $-7.7 \text{ dbm} \pm 0.2 \text{ db}$ output at J4.

- l. Connect rf voltmeter via rf probe to junction of C10, L2, C42.

- h. Connect rf voltmeter together with 50 ohm load to J3 and connect 50 ohm load to J4. The output at J3 should be $-5 \text{ dbm} \pm 1 \text{ db}$.

- m. Perform the signal level checks in Table 4-11.

Table 4-11. SIGNAL LEVEL CHECKS

- i. Repeat steps e and f.

J1		SIGNAL LEVEL (dbm)
FREQ (MHz)	LEVEL (dbm)	(Junction C10, L2, C42)
169	+2±0.5	+9±2
120	+2±0.5	+9±2
80	+2±0.5	+9±2

- j. Perform the output level checks in Table 4-10.

- k. Disconnect signal generator from J2.

- n. Disconnect test equipment and replace module cover.

4-73. 10 MHz Main Loop VCO (6160A-4110)

4-74. This module is removed from the synthesizer and aligned with the following equipment.

- Power Supply.
- Signal Generator.
- RF Voltmeter (with rf probe).
- Digital Voltmeter.
- Frequency Counter.
- 50 ohm load.
- 33k, $\frac{1}{4}$ W Resistor.
- 39k, $\frac{1}{4}$ W Resistor.
- 130 Ω , $\frac{1}{4}$ W Resistor.

4-75. Figure 4-18 shows adjustment, test point and input/output connector locations on the 10 MHz D.U. Main VCO module. Alignment is as follows:

- Remove the cover from the module.
- Apply a 10 MHz signal having a level of 200 ± 20 mV to TP3.
- Connect the input of an rf voltmeter (probe) to TP4. Connect probe ground lead to TP2.
- Adjust C8 for minimum rms voltage at TP3 (less than 2 mV).
- Tune the signal generator from 10 to 19 MHz, observing that the rms voltage at TP3 does not exceed 15 mV.
- Disconnect the signal generator and rf voltmeter from the module.
- Apply dc voltages (+5V, +14V, -12V) to the appropriate feed-thru connectors on the module. Connect power supply common to the module chassis.
- Jumper "4" and "1" feed-thru connectors to ground.
- Connect a 130 Ω , $\frac{1}{4}$ W resistor between J1 and

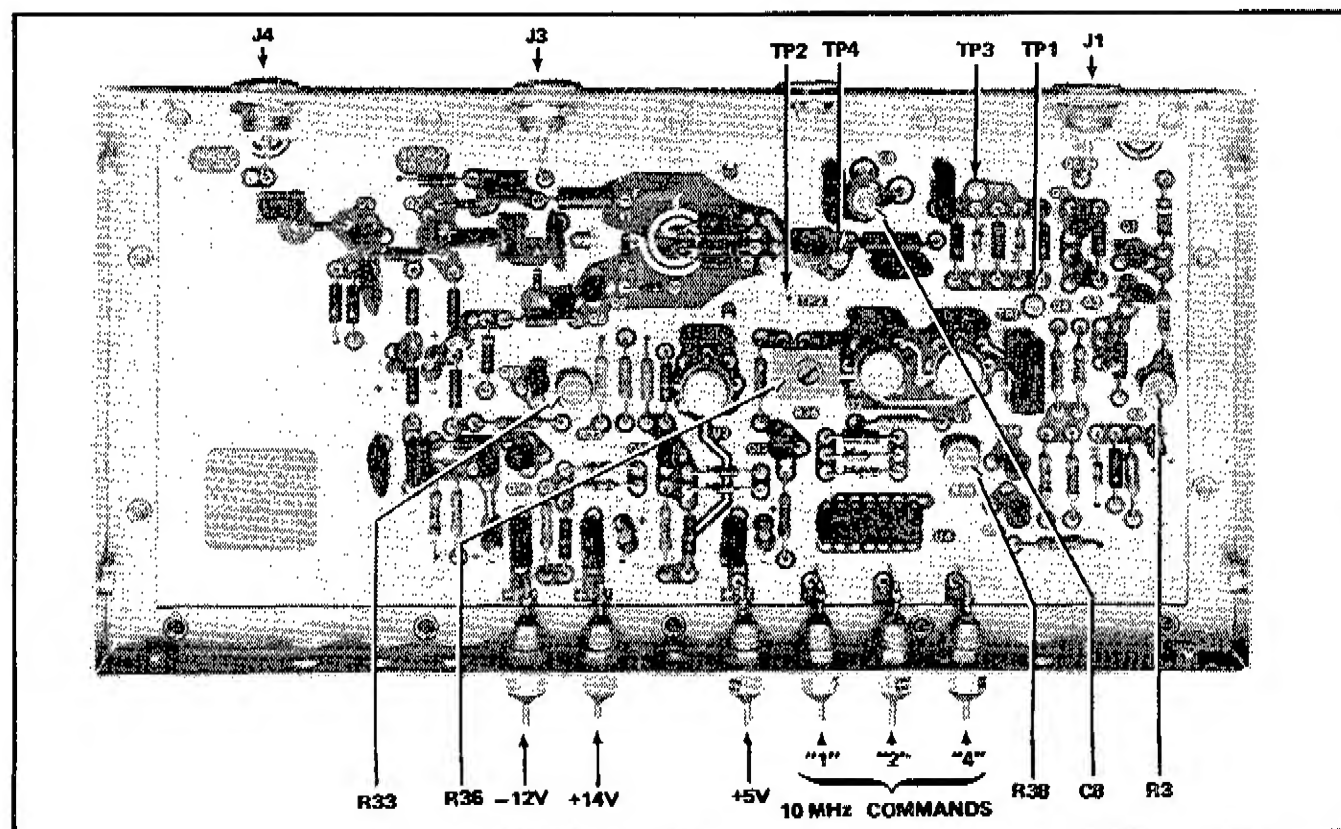


Figure 4-18. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4110)

- j. Connect the rf voltmeter together with a 50 ohm load to J3.
- k. Connect the input of a frequency counter to J4.
- l. Connect the input of a digital voltmeter to TP (+) and TP2 (-).
- m. Adjust R3 such that voltage at TP1 transitions between lower and upper levels. This can also be observed via the frequency counter connected to J4.
- n. Connect the digital voltmeter input (+) to J1, observing that the voltage is 0 ± 10 mVdc.
- o. Repeat steps 1 thru n until results are obtained without further adjustment.
- p. Connect the digital voltmeter to TP1 (+) and TP2 (-).
- q. Apply -12 Vdc via a 33k, 1/4W resistor to J1 and jumper "4", "2" "1" feed-thru connectors to ground.
- r. Adjust R33 for a 75 MHz ± 200 kHz output at J4. The voltage at TP1 should be greater than +0.5 Vdc.
- s. Apply +14 Vdc via a 39k, 1/4W resistor to J1 and then adjust R38 for a 96 MHz ± 100 kHz output at J4.
- t. Disconnect jumpers from "4", "2", "1" feed-thru connectors and then adjust R36 for a 165 MHz ± 200 kHz ± 0 output at J4. The voltage at TP1 should be less than +11.5 Vdc.

NOTE!

If voltage at TP1 is not within limits, change length of coils (L11 and L12). Longer coils yield higher voltage. Shorter coils decrease voltage.

- u. Perform the frequency tracking checks in Table 4-12. Adjust, as necessary, R33, R38 and R36 per Table 4-13 until tracking limits are met.
- v. Disconnect frequency counter from J4.

Table 4-12. FREQUENCY TRACKING CHECKS

J1 INPUT ①= 33k, 1/4w ②= 39k, 1/4w	GROUND JUMPERS	OUTPUT FREQ. J4 (MHz)
-12V via ①	4, 2, 1	65 to 75
+14V via ②	4, 2, 1	95 to 99
-12V via ①	4, 2	75 to 85
+14V via ②	4, 2	105 to 109
-12V via ①	4, 1	85 to 95
+14V via ②	4, 1	115 to 119
-12V via ①	4	95 to 105
+14V via ②	4	125 to 129
-12V via ①	2, 1	105 to 115
+14V via ②	2, 1	135 to 139
-12V via ①	2	115 to 125
+14V via ②	2	145 to 149
-12V via ①	1	125 to 135
+14V via ②	1	155 to 159
-12V via ①	NONE	135 to 145
+14V via ②	NONE	165 to 169

NOTE: Ensure 130 Ω , 1/4w resistor is connected from J1 to ground.

Table 4-13. TRACKING LIMIT ADJUSTMENTS

ADJUSTMENT	AFFECT
R33	Changes low frequency (-12V input to J1)
R38	Changes high frequency (+14V input to J1)
R36	Changes maximum frequency (+14V input to J1)

- w. Apply -12 Vdc via a 33k, 1/4W resistor to J1 and jumper the following feed-thru connectors to ground, observing that the output signal at J3 is +1.5 dbm ± 1.5 db.

Feed-Thru

"4", "2", "1"
"4", "2"
"4", "1"
"4"

- x. Apply +14 Vdc via a 39k, 1/4W resistor to J1, and jumper the following feed-thru connectors to ground, observing that the output signal at J3 is +1.5 dbm ± 1.5 db.

Feed-Thru

"2", "1"
"2"
"1"
NONE

- y. Connect the rf voltmeter together with a 50 ohm load to J4 and repeat steps w, and x, observing that the output signal at J4 is $+4 \text{ dbm} \pm 1.5 \text{ db}$.
- z. Disconnect test equipment and replace module cover.

4-76. Output Divider (6160A-4111)

4-77. Alignment of this module is done in the synthesizer using the following equipment:

- a. Spectrum Analyzer.
- b. Counter.
- c. Signal Generator.
- d. RF Voltmeter.
- e. 6 db Pad.

4-78. Figure 4-19 shows adjustment, test point, and input/output connector locations for this module. Alignment of this module is as follows:

- a. Remove module enclosure cover.
- b. Connect 4110 OUT (J3) to a 6 db pad. Connect output of 6 db pad to -4111 INPUT (J4).
- c. Connect counter through 50 ohm cable to RF OUTPUT connector on front panel. Terminate-counter input with 50 ohm load.
- d. Set front panel controls as follows:

Frequency Dials	150.000000
FUNCTION	10 - 160 MHz
OUTPUT LEVEL	Midposition
- e. Remove connections to J1 and J3 on -4109 module. Apply power to Model 6160A.
- f. Note the frequency on the counter. (This frequency is referenced as f_1 , in Table 4-14. Perform steps 1 through 6 in Table 4-14 and note frequency on counter.

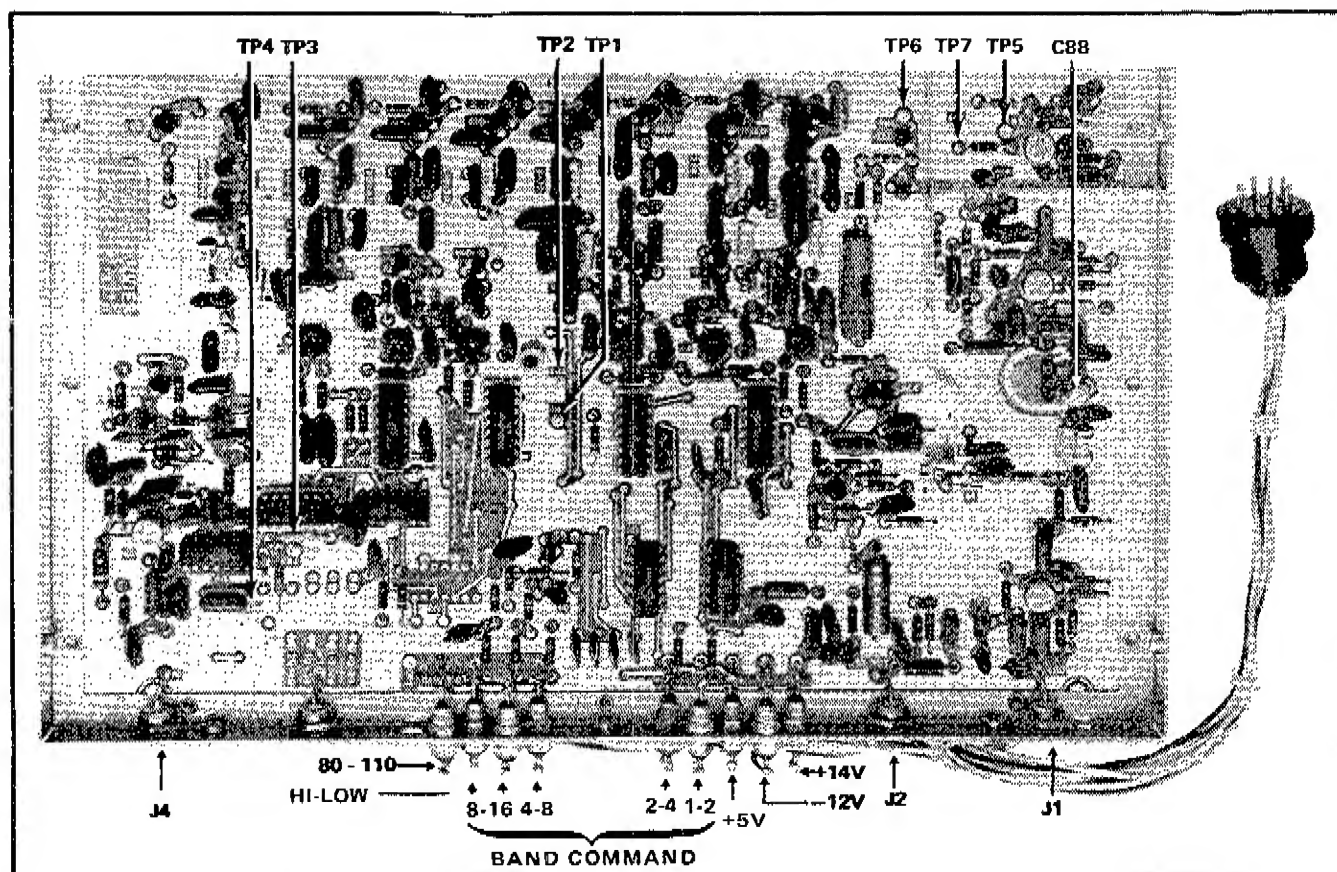


Figure 4-19. ADJUSTMENT, TEST POINT, INPUT/OUTPUT CONNECTOR LOCATIONS (6160A-4111)

Table 4-14. OUTPUT DIVIDER CHECKS

STEP NO.	FRONT PANEL DIAL SETTING	COUNTER FREQUENCY
1	79.000000	$f_1/2$
2	39.000000	$f_1/4$
3	19.000000	$f_1/8$
4	07.900000	$f_1/20$
5	03.900000	$f_1/40$
6	01.900000	$f_1/80$

Table 4-15. OUTPUT DIVIDER LEVEL CHECKS

STEP NO.	MHz DIAL CONTROLS	RF VOLTmeter INDICATION
1	1.00 to 1.99 in 100 kHz steps	+14 dbm \pm 5 db
2	2.00 to 3.99 in 100 kHz steps	
3	4.00 to 7.99 in 1 MHz steps	
4	8.00 to 11.99 in 1 MHz steps	
5	10.00 to 19.99 in 1 MHz steps	
6	20.00 to 39.99 in 1 MHz steps	
7	40.00 to 79.99 in 10 MHz steps	
8	80.00 to 159.99 in 10 MHz steps	

- g. Set front panel frequency dials to 110.000000 MHz and note frequency on counter. (This frequency will be referenced as f_2).
- h. Set front panel frequency dials to 11.000000 MHz. The frequency on the counter must equal $f_2/10$.
- i. Remove 6 db pad and connect signal generator to -4111 INPUT (J4).
- j. Connect spectrum analyzer to RF OUTPUT connector on front panel.
- k. Set front panel frequency dials to 150.000000 and set signal generator to 206.5 MHz at 0 dbm.
- l. Adjust C88 for a minimum indication of 206.5 MHz on spectrum analyzer.
- m. Install module enclosure covers. Install J1 and J3 connections to the -4109 module and connect -4110 OUTPUT (J3) directly to -4111 INPUT (J4).

4-79. Front Panel PCB Assembly (6160A-4051)

4-80. Use the following equipment for adjustment of the Front Panel PCB Assembly.

- a. RF Voltmeter.
- b. Compensated 50 ohm In-Line Adaptor for RF Voltmeter.

4-81. Figure 4-4 shows adjustment locations on the Front Panel PCB Assembly. Use the following procedure for adjusting this pcb assembly.

- a. Connect rf voltmeter through 50 ohm in-line load to RF OUTPUT connector on front panel.
- b. Set OUTPUT LEVEL control to +13 dbm position.
- c. Set FUNCTION switch 10-160 MHz and frequency dials to 10.000000 MHz.
- d. Adjust R4 (refer to Figure 4-4 for location) for +13 dbm \pm 1 db indication on rf voltmeter.
- e. Rotate most significant decade dial from position 1 to 15 and observe that rf voltmeter indication is +13 dbm \pm 1 db. Readjust R4 if necessary.
- f. Set FUNCTION switch to 1-12 MHz and rotate most significant decade dial from position 1 to 12. RF Voltmeter should indicate +13 dbm \pm 1 db. If readjustment of R4 is necessary, recheck step d with FUNCTION switch set to 10-160 MHz.
- g. Set OUTPUT LEVEL control to +3 dbm position, set FUNCTION switch to 10-160 MHz and frequency dials to 10.000000.
- h. Adjust R6 (Refer to Figure 4-4 for location) for +3 dbm \pm 1 db.
- i. Rotate most significant decade dial from positions 1 to 15 observing that rf voltmeter indicates +3 dbm \pm 1 db. Readjust R6 if necessary.
- j. Set FUNCTION switch to 1-12 MHz and rotate most significant decade dial from positions 1 to 12. Observe that rf voltmeter indicates +3 dbm. If readjustment of R6 is necessary, repeat step h with FUNCTION switch set to 10-160 MHz.
- k. Remove all test equipment.

4-82. TROUBLESHOOTING

4-83. Troubleshooting of the Model 6160B can be categorized into two separate conditions: (1) Catastrophic, where no outputs (Buffered 5 MHz output or 1 - 160 MHz output) are present, (2) Synthesizing errors, where incorrect output frequencies are obtained. The first malfunction can usually be attributed to a power supply problem. Isolation of a synthesizing error, however, is somewhat more difficult and may require a thorough understanding of the synthesizer block diagram. It is, therefore, recommended that the contents of Section 3 be read. Input/output connectors, testpoint, and adjustment locations for each module or assembly can be found in the alignment section for each module or assembly. In addition, Table 4-16 lists dialed frequencies with corresponding computer output commands and output frequencies from the Six Digit Generator, 1 MHz Generator, and 10 MHz Generator.

4-84. Figure 4-20 shows assembly locations of each

assembly and module referred to in the troubleshooting chart (Drawing No. 6160B-1600). Drawing No. 6160B-1600, located in the schematic section of this manual, is a troubleshooting chart for the Model 6160B with the -02, -04, or -05 options. Synthesis OK implies the frequency is synthesized at the desired frequency. All frequencies in Drawing No. 6160B-1600 are in MHz and are measured without disrupting the path by utilizing the JF 207092 and 707100 adaptors, spare cable, BNC Tee, and high impedance counter. Always check for proper supply and command voltages as well as rf input signals at the suspected module before removal and disassembly of the module. Table 4-17 lists expected output levels at various interface points. Signal levels are typical values and may vary several db between instruments. Level measurements are made without disrupting the signal path by utilizing the JF207092 and 207100 adaptors, spare cable, and BNC-to-scope adaptor contained in the service kit (6160A-7006). Coax line length must be kept at a minimum for the Tee to scope probe.

Table 4-16. COMPUTER OUTPUT COMMANDS

DIALED FREQUENCY MHz	COMPUTER OUTPUT DIGITAL COMMANDS TO EACH DECADE								SIX DIGIT GENERATOR OUTPUT FREQUENCY MHZ (6040A-4102,J2)	1 MHz DIGIT GENERATOR OUTPUT FREQUENCY MHZ (6160B-4153-2, J1)	10 MHz DIGIT GENERATOR OUTPUT FREQUENCY MHZ (6160A-4110, J3)
	10 MHZ	1 MHZ	100 kHz	10 kHz	1 kHz	100 Hz	10 Hz	1 Hz			
10-160 MHz RANGE											
80.000000	0	0	0	0	0	0	0	0	20.00000	10.000000	80.000000
81.111111	0	2	2	2	2	2	2	2	22.22222	11.111111	81.111111
82.222222	0	4	4	4	4	4	4	4	24.44444	12.222222	82.222222
93.333333	1	6	6	6	6	6	6	6	26.66666	13.333333	93.333333
104.444444	2	8	8	8	8	8	8	8	28.88888	14.444444	104.444444
115.555555	3	11	1	1	1	1	1	0	21.11110	15.555555	115.555555
126.666666	4	13	3	3	3	3	3	2	23.33332	16.666666	126.666666
137.777777	5	15	5	5	5	5	5	4	25.55554	17.777777	137.777777
148.888888	6	17	7	7	7	7	7	6	27.77776	18.888888	148.888888
159.999999	7	19	9	9	9	9	9	8	29.99998	19.999999	159.999999
10.875000	0	14	0	0	0	0	0	0	20.00000	17.000000	87.000000
30.875000	4	7	0	0	0	0	0	0	20.00000	13.500000	123.500000
40.875000	0	3	5	0	0	0	0	0	25.00000	11.750000	81.750000
80.650000	0	1	3	0	0	0	0	0	23.00000	10.650000	80.650000
20.650000	0	5	2	0	0	0	0	0	22.00000	12.600000	82.600000
19.500000	7	12	0	0	0	0	0	0	20.00000	16.000000	156.000000
39.500000	7	16	0	0	0	0	0	0	20.00000	18.000000	158.000000
79.500000	7	18	0	0	0	0	0	0	20.00000	19.000000	159.000000
42.250000	0	9	0	0	0	0	0	0	20.00000	14.500000	84.500000
125.250000	4	10	5	0	0	0	0	0	25.00000	15.250000	125.250000
1-12 MHz RANGE											
1.9990000	7	19	8	4	0	0	0	0	28.40000	19.920000	159.920000
3.9990000	7	19	9	2	0	0	0	0	29.20000	19.960000	159.960000
7.9247500	7	16	9	9	0	0	0	0	29.90000	18.550000	158.550000
8.0004997	0	0	0	0	9	9	9	8	20.09998	10.004999	80.004999

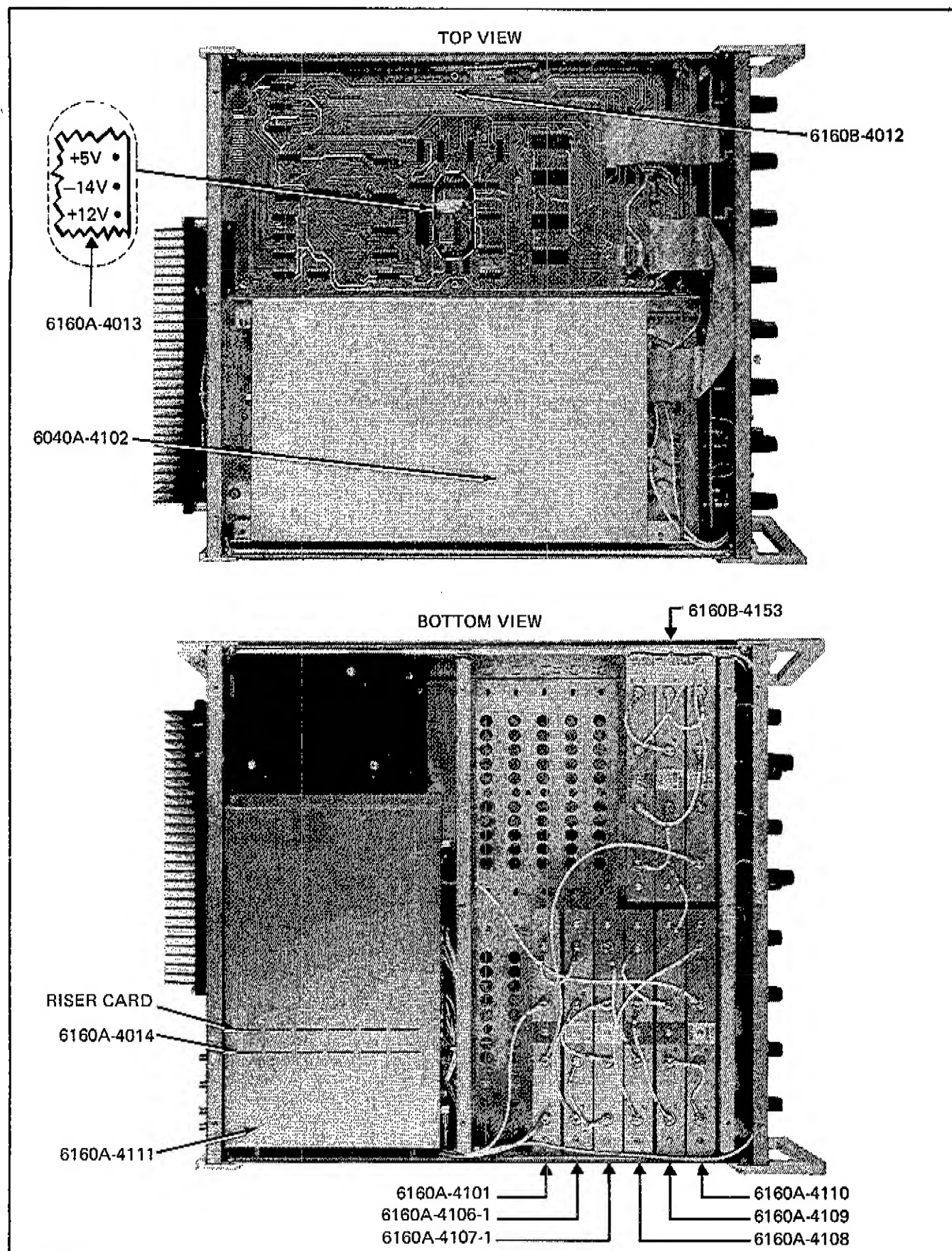
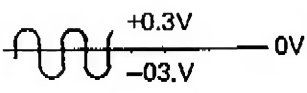
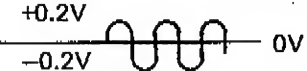



Figure 4-20. MODEL 6160B ASSEMBLY LOCATIONS

Table 4-17. INTERFACE LEVEL

MODULE	JACK	LEVEL
4101 INPUT FILTER	J2 J3 J4	TTL 2V rms open CKT 2V p-p sine wave
4102 6-DIGIT GENERATOR	J3 J2	TTL TTL
4153-2 1 MHz DIGIT GENERATOR MODULE SET	J1	
4106-1 10 MHz STEP LOOP PHASE DETECTOR	J2 J3	$\leq \pm 0.01$ VDC $0.1V \pm 0.1V$ or $0.7V$
4107-1 10 MHz STEP LOOP VCO	J3 J4	250 mV rms sine wave 300 mV rms sine wave
4108 10 MHz IF MIXER	J3 J4	+0.2V -0.2V Same as above 
4109 10 MHz MAIN LOOP PHASE DETECTOR	J2	DC Voltage $< \pm 0.4V$
4110 10 MHz MAIN LOOP VCO	J3 J4	0.3V rms sine wave 0.3V rms sine wave
4111 OUTPUT DIVIDER	J1	1V rms with 1-160 MHz output terminated into 50Ω
NOTE: TTL=		

4-85. Reference to Note A, B, C, or D in Drawing No. 6160B-1600, refers to the following notes:

NOTE A!

The $-12V$ supply is used as a reference for the $+14$ and $+5V$ supplies, therefore, a malfunction on the $-12V$ supplies will make the $+14V$ and $+5V$ supplies inoperative.

NOTE B!

Isolation of 4106-1 and 4107-1 problems. A signal at 4107-1J4 that is more than ± 3 MHz from the desired frequency indicates a failure of the 4107-1 module. If the error is less than ± 2 MHz the 4106-1 module is probably at fault. Remove connection to 4107-1J1 and check for the best (error frequency) signal of 30 - 50 mV p-p into 50 ohm and less than 1.5MVdc offset coming from the 4106-1 module. If no beat is present, there is a definite failure of the 4106-1 module. If the beat is present, continue with the following two-step test.

- Shunt 4107-1J1 with a 120 ohm resistor and remove connection to 4107-1J2. Load this port with a 1 kilohm load. Insert $+40\mu A$ into J1, (use a 0.35 resistor to $+14V$ supply). Check that frequency at 4107-1J4 is 1.7 to 3.3 MHz above desired frequency and that approximately minus 1.5 to $-1.8V$ is across the 1 kilohm load at 4107-1J2.
- With resistors installed as in step A., pull minus 40 Ma from 4107-1J1, (use 0.3 resistor to $-12V$ supply). Check 4107-1J4 frequency. It must be 1.7 to 3.3 MHz below desired frequency and indicate from $+1.0$ to $+1.2V$ across the load resistor on 4107-1J2. If conditions described in steps A. and B. are not met the 4107-1 Module is defective. If these conditions are met, the 4106-1 is faulty. The following table, (Table 4-18) indicates desired 4107-1J4 Frequency vs. 10MHz Dial Position.

Table 4-18. 6160A-4107-1, J4 FREQUENCY

DIAL	FREQUENCY
8	70 MHz
9	80 MHz
10	90 MHz
11	100 MHz
12	110 MHz
13	120 MHz
14	130 MHz
15	140 MHz

NOTE C!

Vary the digit indicated by X and check for synthesis at each position of this switch in the case of all digits except the 10MHz digit. For the 10MHz digit range from 8 to 15.

NOTE D!

Isolation of 4109 and 4110 troubles. Open connection to 4110-J1. Voltage at J1 must be less than $\pm 0.4V$. Apply 1.4mA with a 10 kil-ohm resistor from the +14V supply into 4110-J1. Frequency at 4110-J3 must be higher than the 10MHz dial setting by 15MHz. Remove resistor to +14V supply and connect to 12V supply to draw 1.2mA from 4110-J1. Frequency at 4110-J3 must be lower than 10MHz dial setting by 5MHz. If these conditions are not met the fault is in the 4110 module. If these conditions are met, the fault is likely in the 4109 Module.

4-86. The following tables (Table 4-19 and Table 4-20) list the voltage present on C1, C2, C3, and J13 of the -4013 Mother Board assembly referenced in Drawing No. 6160B-1600.

Table 4-19. J13, AC VOLTAGES

PIN	AC VOLTAGE	PIN	AC VOLTAGE
1	0	A	(1) 0
2	0	B	0
3	$19.7 \pm 15\%$	C	$19.7 \pm 15\%$
4	0	D	0
5	0	E	0
6	$19.7 \pm 15\%$	F	$19.7 \pm 15\%$
7	9.9	H	9.9
8	9.9	J	9.9
9	9.9	K	9.9
10	9.9	L	9.9

NOTE: Gain access to J13 by removing top cover and hinging up 4102 module after removing the four screws securing it to synthesizer.

Table 4-20. UNREGULATED SUPPLY VOLTAGES

TEST POINT	VDC
C3 (+) terminal	$+25.2 \pm 15\%$
C2 (-) terminal	$-25.4 \pm 15\%$
C1 (+) terminal	$+11.7 \pm 15\%$

NOTE: Gain access to test points by removing top cover and hinging up the 4102 module after removing the four screws securing it to the synthesizer.

Section 5

Lists of Replaceable Parts

TABLE OF CONTENTS

REFERENCE DESIGNATOR	ASSEMBLY NAME/NUMBER	PART NO.	PAGE
	Frequency Synthesizer Final Assembly (6160B)	6160B	5-3
A1	Front Panel Assembly (6160B-4451)	356519	5-11
A1A1	Front Panel PCB Assembly (6160A-4051-03)	323162	5-13
A2	10 MHz Main Loop VCO Module Assembly (6160A-4110)	323741	5-15
A2A1	10 MHz Main Loop VCO PCB Assembly (6160A-4010)	—	5-16
A3	10 MHz Main Loop Phase Detector Module Assembly (6160A-4109)	323733	5-20
A3A1	10 MHz Main Loop Phase Detector PCB Assembly (6160A-4009)	—	5-21
A4	10 MHz IF Mixer Module Assembly (6160A-4108)	323725	5-26
A4A1	10 MHz IF Mixer PCB Assembly (6160A-4008)	—	5-27
A5	10 MHz Step Loop VCO Module Assembly (6160A-4107-1)	341545	5-32
A5A1	10 MHz Step Loop VCO PCB Assembly (6160A-4007)	—	5-33
A6	10 MHz Step Loop Phase Detector Module Assembly (6160A-4106-1)	341537	5-39
A6A1	10 MHz Step Loop Phase Detector PCB Assembly (6160A-4006)	—	5-40
A7	Input Filter Module Assembly (6160A-4101)	323667	5-46
A7A1	Input Filter PCB Assembly (6160A-4001)	—	5-47
A8	1 MHz Digit Generator Matched Module Set Assembly (6160B-4153-1/-2/-3)	356444	5-50
A8A1	1 MHz Matched Module Pair (6160B-4153-1/-2)	—	5-51
A8A1A1	1 MHz Step Loop PCB Assembly (6040A-4003)	—	5-52
A8A1A2	1 MHz Main Loop PCB Assembly (6160B-4005)	—	5-57
A8A2	1 MHz Main Loop Phase Detector Module Assembly (6160B-4153-3)	—	5-61
A8A2A1	1 MHz Main Loop Phase Detector PCB Assembly (6040A-4004)	—	5-62

1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C35	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101 F103M	1		
C37	Cap, mica, 4 pf, $\pm 5\%$, 500V	190397	53021	D15C040K	REF		
C38 thru C46	Cap, feed-thru	248286	00656	BSF-1BB	9		
CR2, CR3	Diode pair, matched set <i>NOTE!</i> <i>Varactor tuning diodes CR2 and CR3 are matched to CR1 and CR2 in the 1 MHz Main Loop VCO PCB Assembly, A8A1A2. If replacement is required, two matched sets must be ordered. When replacing these diodes, install one diode from each set in the A8A1A1 pcb assembly. Install the remaining diodes of each set in the A8A1A2 pcb assembly.</i>	347534	89536	347534	REF		
CR4	Diode, si, 150mA	203323	03508	1N4148	1	1	
J1 thru J4	Conn, male, coax.	207639	13511	27-875	4		
L1	Choke, 6 turn	320911	89536	320911	11		
L2	Inductor, Type 10K	339234	89536	339234	1		
L3	Choke, RF, 270 uh $\pm 5\%$, 260 mA	186270	72259	WEE-270	1		
L4, L5	Choke, 6 turn	320911	89536	320911	REF		
L6	Choke, RF, 180 uh, $\pm 5\%$, 300 mA	174771	72259	WEE-180	1		
L7	Choke, 6 turn	320911	89536	320911	REF		
L8	Choke, RF, 120 uh, $\pm 10\%$, 330 mA	321042	72259	WEE-120	1		
L9 thru L14, L16	Choke, 6 turn	320911	89536	320911	REF		
Q2 thru Q5	Xstr, si, NPN	248351	04713	MPS918	4	1	

FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	6160B INSTRUCTION MANUAL	382028	89536	382028	1		
	FREQUENCY SYNTHESIZER	6160B	89536	—			
	FINAL ASSEMBLY						
	Figure 5-1 Sheets 1, 2, 3						
A1	Front Panel Assembly 6160B-4451	356519	89536	356519	1		
A2	10 MHz Main Loop VCO Module Assembly 6160A-4110	323741	89536	323741	1		
A3	10 MHz Main Loop Phase Detector Module Assembly 6160A-4109	323733	89536	323733	1		
A4	10 MHz IF Mixer Module Assembly 6160A-4108	323725	89536	323725	1		
A5	10 MHz Step Loop VCO Module Assembly 6160A-4107-1	341545	89536	341545	1		
A6	10 MHz Step Loop Phase Detector Module Assembly 6160A-4106-1	341537	89536	341537	1		
A7	Input Filter Module Assembly 6160A-4101	323667	89536	323667	1		
A8	1 MHz Digit Generator Module Set 6160B-4153	356444	89536	356444	1		
A9	Six Digit Generator Module Assembly 6040A-4102	367094	89536	367094	1		
A10	Computer PCB Assembly 6160B-4012	356287	89536	356287	1		
A11	Output Divider Module Assembly 6160A-4111	323758	89536	323758	1		
A12	Power Supply PCB Assembly 6160A-4014	322933	89536	322933	1		

FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A13	Mother Board PCB Assembly 6160B-4013	356295	89536	356295	1		
A14	Riser Card, PCB 6160A-4015	323147	89536	323147	1		
A15	Transformer Enclosure Assembly 6160A-4116	323493	89536	323493	1		
A16	Heat Sink Assembly 6160A-4021	323154	89536	323154	1		
A17	Rear Panel Assembly 6160A-4452	324616	89536	324616	1		
C1	Cap, elect, 15,000 uf, 15V	310367	06001	86F520	1		
C2, C3	Cap, elect, 2900 uf, 40V	325779	06001	86F555	2		
<p>NOTE!</p> <p>The following items 1 through 8 can be found on Figure 5-1, Sheet 1 of 3.</p>							
1	Cover, top	323386	89536	323386	1		
2	Bottom cover	323394	89536	323394	1		
3	Screw, 6 - 32 x 1/4 FLH - Phillips, 82° undercut	320093	73734	Order by Description	12		
4	Foot	292870	89536	292870	4		
5	Screw, FLH-Phillips, #8 - 32 x 7/16	306159	73734	18265	4		
6	Decal, corner	296277	89536	296277	4		
7	Decal, side trim	295394	89536	295394	2		
8	Decal, handle trim	295501	89536	295501	2		
<p>NOTE!</p> <p>The following items 9 through 31 can be found in Figure 5-1, Sheet 2 of 3.</p>							

FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
9	Bracket, card slide	323287	89536	323287	1		
10	Bracket, support, Output Divider	324582	89536	324582	1		
11	Bulkhead, center	323253	89536	323253	1		
12	Bushing, snap, black nylon	242164	28520	SB-750-10	1		
13	Chassis Assembly	356451	89536	356451	1		
14	Clamp, capacitor, elect	185801	56289	4586-97A	3		
15	Corner, rear	295998	89536	295998	2		
16	End plate	345538	89536	345538	1		
17	Nut, hex, 4 - 40	152819	78199	51106180000	3		
18	Screw, 4 - 40 x 1/4 FLH - Phillips	114884	73734	18222	2		
19	Screw, 4 - 40 x 1/4 lock-type SEMS	185918	73734	Order by Description	6		
20	Screw, 4 - 40 x 3/8 PNH - Phillips	281196	73734	19024	27		
21	Screw, 6 - 32 x 1/4, hex head	347674	73734	5310	2		
22	Screw, 6 - 32 x 1/4, FLH-Phillips 82° undercut	268169	73734	Order by Description	4		
23	Screw, 6 - 32 x 1/4, lock-type SEMS	178533	73734	Order by Description	14		
24	Screw, 6 - 32 x 3/8 lock-type SEMS	177022	73734	Order by Description	3		
25	Screw, 6 - 32 x 5/8 PNH - Phillips	152181	73734	19047	3		
26	Screw, 8 - 32 x 1/4 PNH - Phillips	228890	73734	19063	2		
27	Screw, 8 - 32 x 3/8 FTH - Phillips	114116	73734	18264	8		
28	Screw, 8 - 32 x 1/2 FTH - Phillips	114355	73734	18266	10		

FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
29	Tie, cable	172080	06383	SST-1	1		
30	Washer, lock, internal #4	110403	73734	99402	18		
31	Washer, lock, external #6	169235	73734	1322	2		
	<p><i>NOTE!</i></p> <p><i>The following items 32 through 63 can be found in Figure 5-1, Sheet 3 of 3.</i></p>						
32	Bracket, stiffener	356311	89536	356311	1		
33	Bracket, hinge, left-hand	356337	89536	356337	1		
34	Bracket, hinge, right-hand	367466	89536	367466	1		
35	Cable -23, black	367391	89536	367391	1		
36	Cable -16, violet	367326	89536	367326	1		
37	Cable -15, red	367318	89536	367318	1		
38	Cable -17, yellow	367334	89536	367334	1		
39	Cable -22, brown	367383	89536	367334	1		
40	Cable -21, orange	367375	89536	367375	1		
41	Cable -20, blue	367367	89536	367367	1		
42	Cable -19, green	367359	89536	367359	1		
43	Cable -18, white	367342	89536	367342	1		
44	Cable -12, violet	367284	89536	367284	1		
45	Cable -13, yellow	367292	89536	367292	1		
46	Cable -11, red	367276	89536	367276	1		
47	Cable -14, green	367300	89536	367300	1		
48	Cable -9, blue	367250	89536	367250	1		
49	Cable -8, orange	367243	89536	367243	1		
50	Clip, speed	352666	78553	C26053SS-020	1		
51	Foot, unit	292870	89536	292870	4		
52	Screw, 8-32 x 7/16 FLH 82° undercut slotted	306159	73734	Order by Description	4		
53	Nut, self-locking, KEP	195255	78189	511-041800-00	2		
54	Screw, 4-40 x 1/4 PNH - Phillips	129890	73734	19022	1		

FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
55	Screw, 4 - 40 x 5/16 PNH - Phillips	152116	73734	19023	6		
56	Screw, 6 - 32 x 1/4 PNH - Phillips	152140	73734	19042	6		
57	Screw, 6 - 32 x 1/4, LK-Type, SEMS	178553	73734	Order by Description	4		
58	Screw, 6 - 32 x 3/8, LK-Type, SEMS	177022	73734	Order by Description	5		
59	Screw, 6 - 32 x 3/8 Hex Head	329995	73734	5312	2		
60	Screw, 6-32 x 1/4, LK-Type, SEMS	177030	73734	Order by Description	2		
61	Clamp, cable	104638	06383	SSC-2	2		
62	Washer, flat, fiberglass #4	145638	76854	2-1185-119	1		
63	Washer, fiber	110684	83330	2166	1		
<i>NOTE!</i>							
<i>The following items are not illustrated.</i>							
	Cable, # 1	269969	89536	269969	1		
	Cable, # 2	259747	89536	259749	1		
	Cable, # 3	205831	89536	205831	1		
	Cable, # 4, 9, 10, 11, 12, 15, 19, 20, 21	205757	89536	205757	9		
	Cable, # 7	205880	89536	205880	1		
	Cable, # 8	270116	89536	270116	1		
	Cable, # 13, 14, 18	205765	89536	205765	3		
	Cable, # 16	205856	89536	205856	1		
	Cable, # 17	205799	89536	205799	1		
	Cable, # 22	269977	89536	269977	1		
	Cable, # 23	333096	89536	333096	1		
	Cable, # 24	270264	89536	270264	1		
	Cable, # 25	205773	89536	205773	1		
	Cable, # 26	259622	89536	259622	1		
	Chassis Assembly	356451	89536	356451	1		

FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Screw, PNH, 6 - 32 x 1/4 (Secures Computer PCB and Six-Digit Generator Module)	152140	73734	19042	6		
	Accessory Kit	324913	89536	324913	1		

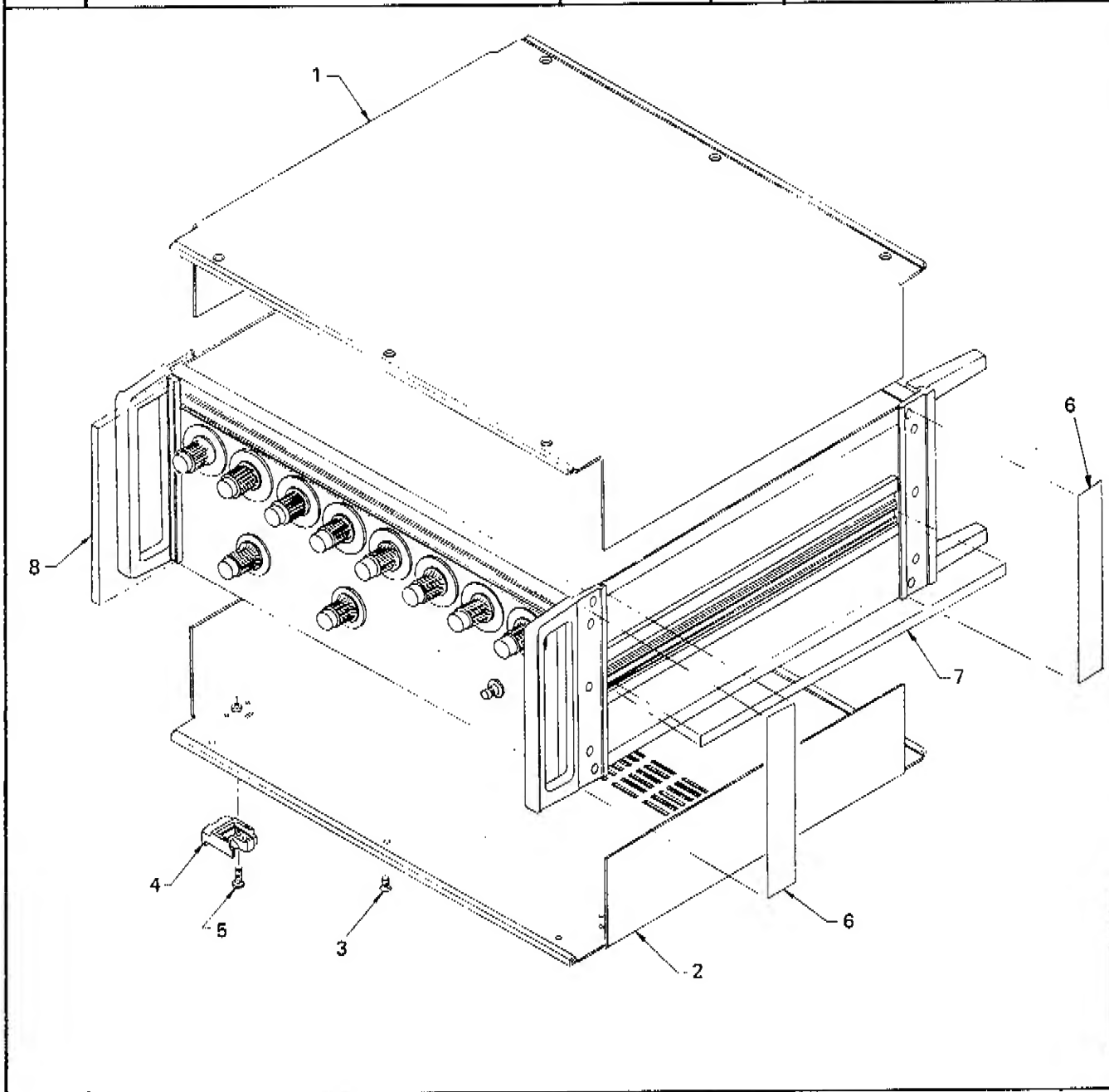


Figure 5-1. FINAL ASSEMBLY (Sheet 1 of 3)

FINAL ASSEMBLY

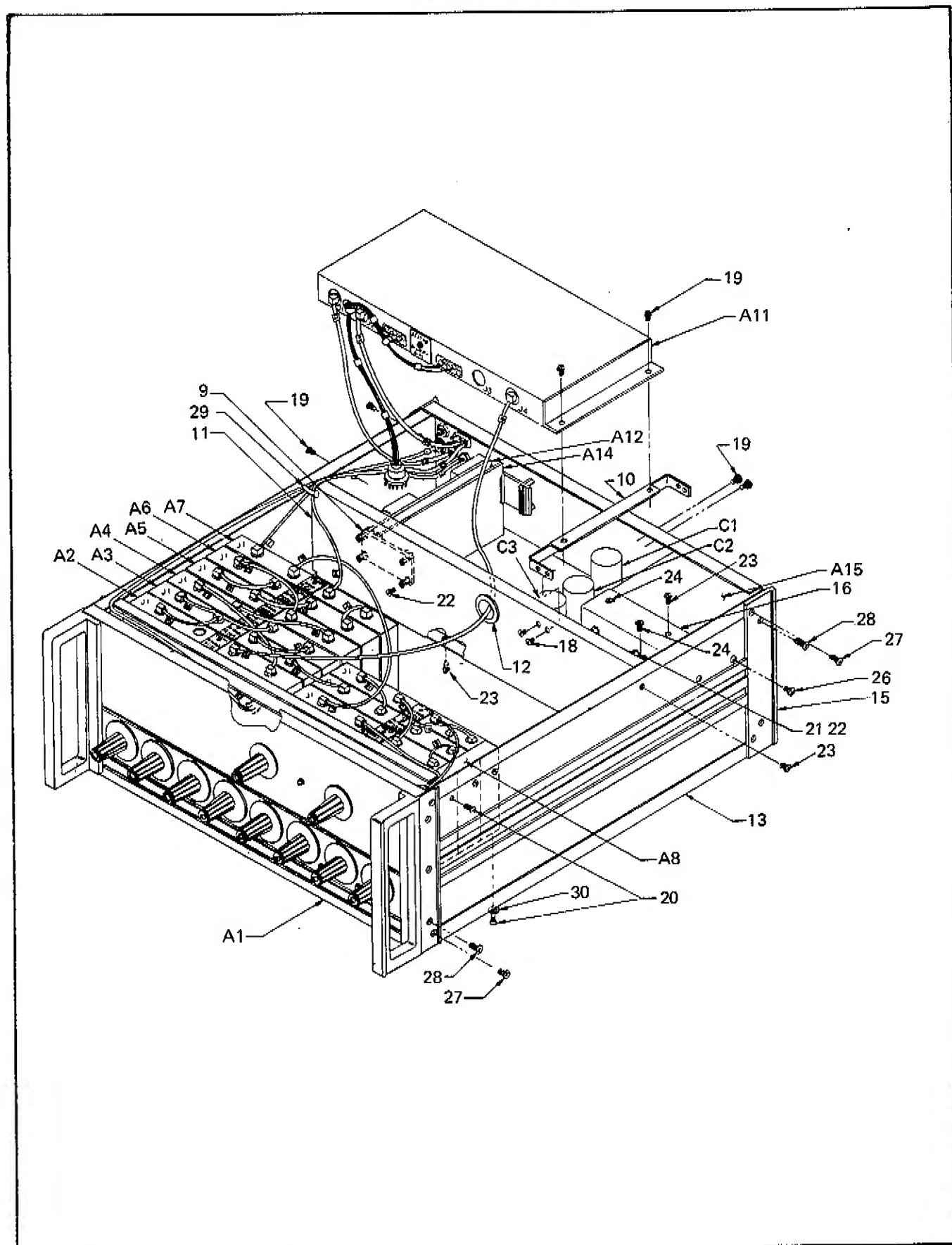


Figure 5-1. FINAL ASSEMBLY (Sheet 2 of 3)

FINAL ASSEMBLY

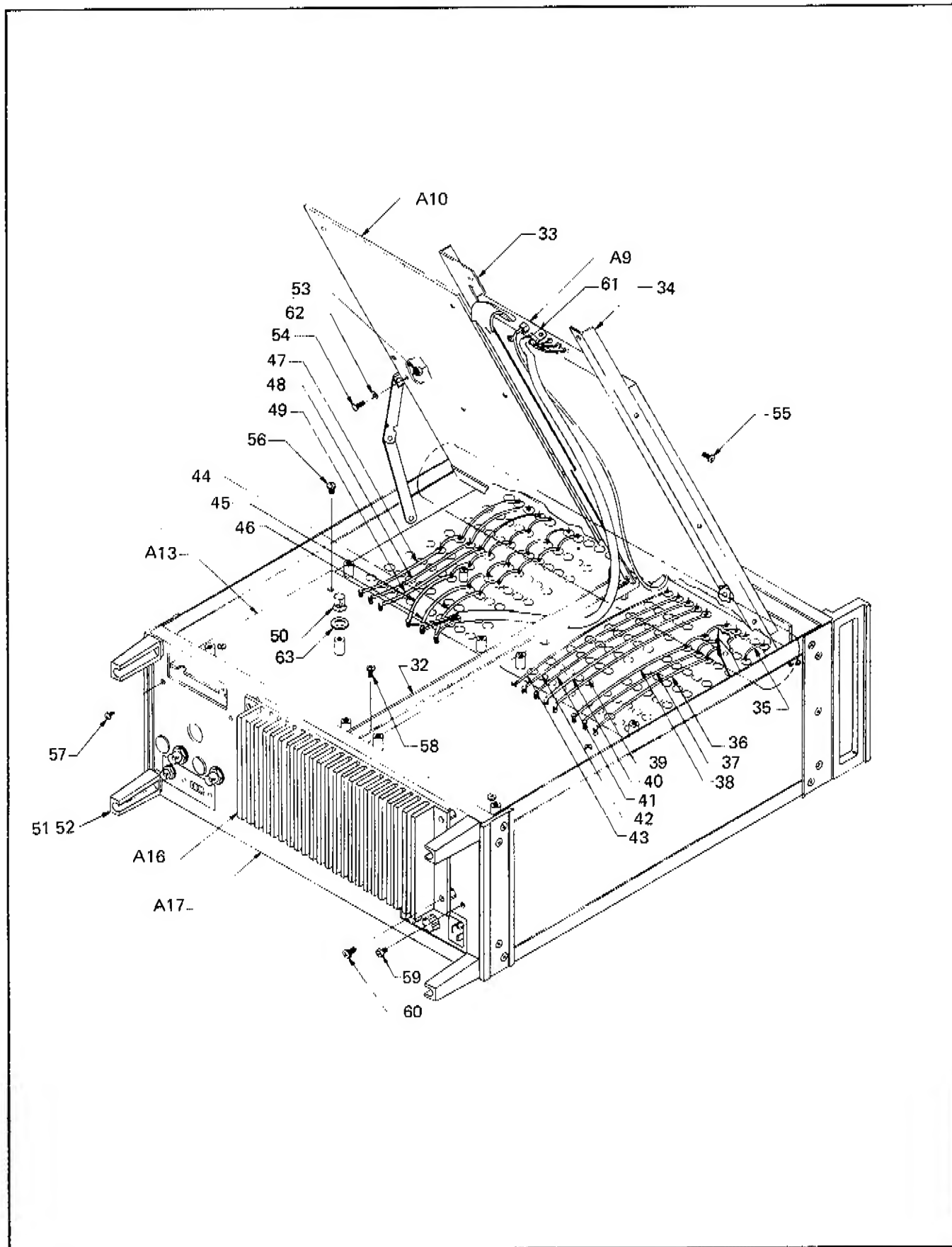


Figure 5-1. FINAL ASSEMBLY (Sheet 3 of 3)

FRONT PANEL ASSEMBLY, A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	FRONT PANEL ASSEMBLY Figure 5-2 6160B-4451	356519	89536	356519	REF		
A1A1	Front Panel PCB Assembly	323162	89536	323162	1		
A1A1 CR2 thru A1A1 CR13	Diode, Ge, 80 mA, 100 piv (Note: A1A1CR2 thru A1A1CR13 are located on Front Panel PCB Assembly, A1A1. When ordering A1A1 assembly, A1A1CR2 thru A1A1CR13 must be ordered separately)	149187	98332	1N270	12	2	
CR1 thru CR4	Diode, light emitting	309617	71318	FLV102	4	1	
A1A1 S1 thru A1A1 S3	Switch, rotary (Note: A1A1S1 thru A1A1S3 are located on Front Panel PCB Assembly, A1A1. When ordering A1A1 assembly, A1A1S1 thru A1A1S3 must be ordered separately)	321091	89536	321091	3		
1	Bracket, corner angle	329151	89536	329151	2		
2	Cable Assembly, rf output	328534	89536	328534	1		
3	Clip, snap-in, with speed nut	309625	07263	FYC 001T	4		
6	Handle, front corner	295675	89536	295675	2		
7	Knob Assembly, 0-9 positions	324863	89536	324863	7		
8	Knob Assembly, 1-15 positions	324855	89536	324855	1		
9	Knob Assembly	324848	89536	324848	2		
10	Name plate	194183	89536	194183	1		
11	Nut, #6 hex	110569	73734	8005	4		
12	Panel, screened front	323188	89536	323188	1		
13	Screw, cap, #8 - 32 x 7/16	295105	74445	8-32 UNRC CLASS 3A	4		

FRONT PANEL ASSEMBLY, A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
14	Screw, #4 - 40 x 3/16, FHD - Phillips	293589	73734	4-40 x 3-16FHD /PHH BLK0X	4		
15	Spacer, 1/8 in.	215210	89536	215210	8		
16	Spacer, 3/16 in.	103499	89536	103499	1		
17	Washer, internal lock	110338	30323	#6	4		
18	Nut, KEP, #6 - 32	152819	78199	51106180000	1		

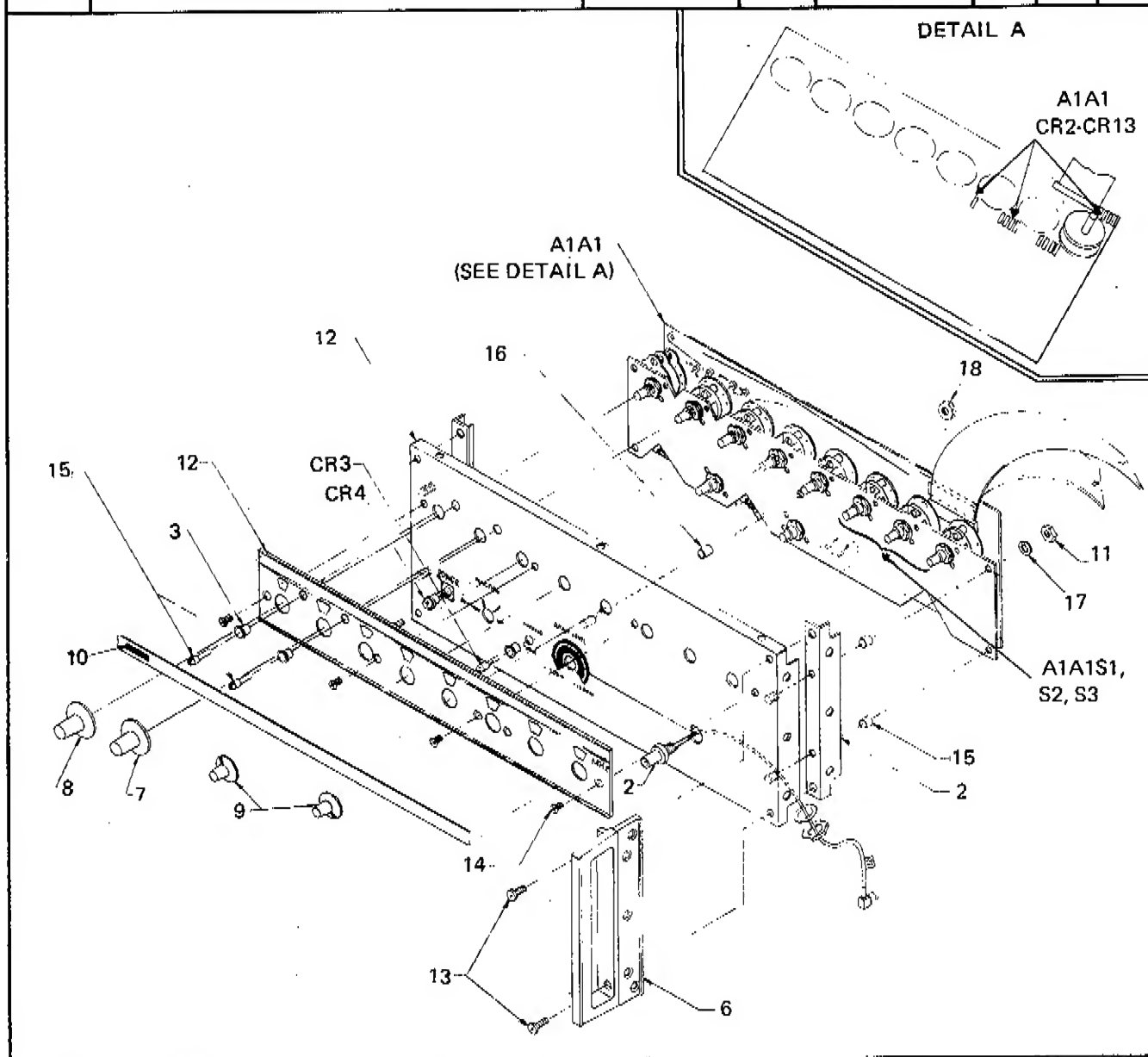


Figure 5-2 FRONT PANEL ASSEMBLY, A1

FRONT PANEL PCB ASSEMBLY, A1A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1A1	FRONT PANEL PCB ASSEMBLY Figure 5-3 6160A-4051-03	323162	89536	323162	1		
C1	Cap elect, 250 uf, +50/-10%, 16V	187765	73445	ET331X016A00	1		
CR1	Not used						
CR2 thru CR13	NOTE! <i>CR2 thru CR13 not included on this assembly. When ordering the A1A1 Assembly, these diodes must be ordered separately. Refer to A1A1 CR2 thru A1A1CR13 under A1 Front Panel Assembly parts list for part number.</i>						
CR14 thru CR33	Diode, germanium, 80 mA, 100 piv	149187	93332	1N270	20		
J1, J2	Connector, PCB to cable	295337	35037	Type 3402	1		
P1, P2	Plug, cable to PCB (not illustrated)	325910	35037	3424	2		
R1, R2	Res, comp, 680Ω, ±5%, ¼W	148007	01121	CB6815	2		
R3	Res, comp, 51Ω, ±5%, ¼W	221879	01121	CB5105	1		
R4	Res, var, cermet, 5k, ±10%, ½W	288282	71450	360S-502A	1		
R5	Res, comp, 6.2k, ±5%, ¼W	221911	01121	CB6225	1		
R6	Res, var, cermet, 2k, ±10%, ½W	285163	11236	360S-202A	1		
R7	Res, var, comp, 1k, ±5%, 2W	255752	80294	3852A-281-102H	1		
R8	Res, comp, 3.9k, ±5%, ¼W	148064	01121	CB 3925	1		
R9, R10	Res, comp, 330Ω, ±5%, ¼W	147967	01121	CB3315	2		
S1 thru S3	NOTE! <i>S1 thru S3 not included on this assembly. When ordering the A1A1 assembly, these switches must be ordered separately. Refer to A1A1S1 thru A1A1S3 under A1 Front Panel Assembly parts list for part number.</i>						
S4 thru S7	Switch, rotary, 10 position	321091	89536	321091	4		

FRONT PANEL PCB ASSEMBLY, A1A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
S8	Switch, rotary, 15 position	321133	89536	321133	1		
S9	Switch, rotary, 4 position	321190	89536	321190	1		
U1	IC, DTL, Quad-2 input nor gate	320689	04713	MC1811P	1		
1	Cover, connector, J1 and J2	295329	35037	TYPE 3402	2		
	Cable, flat	291807	35037	3350	6 in		
	Cable, flat	291807	35037	3350	4 in		
	Nut, hex, 3/8 x 32	110510	73734	3/8 -32NEF2B	7		
	Plate, switch mounting	323428	89536	323428	1		
	Washer, internal lock, 3/8 in.	129957	78189	1220 - 05	7		

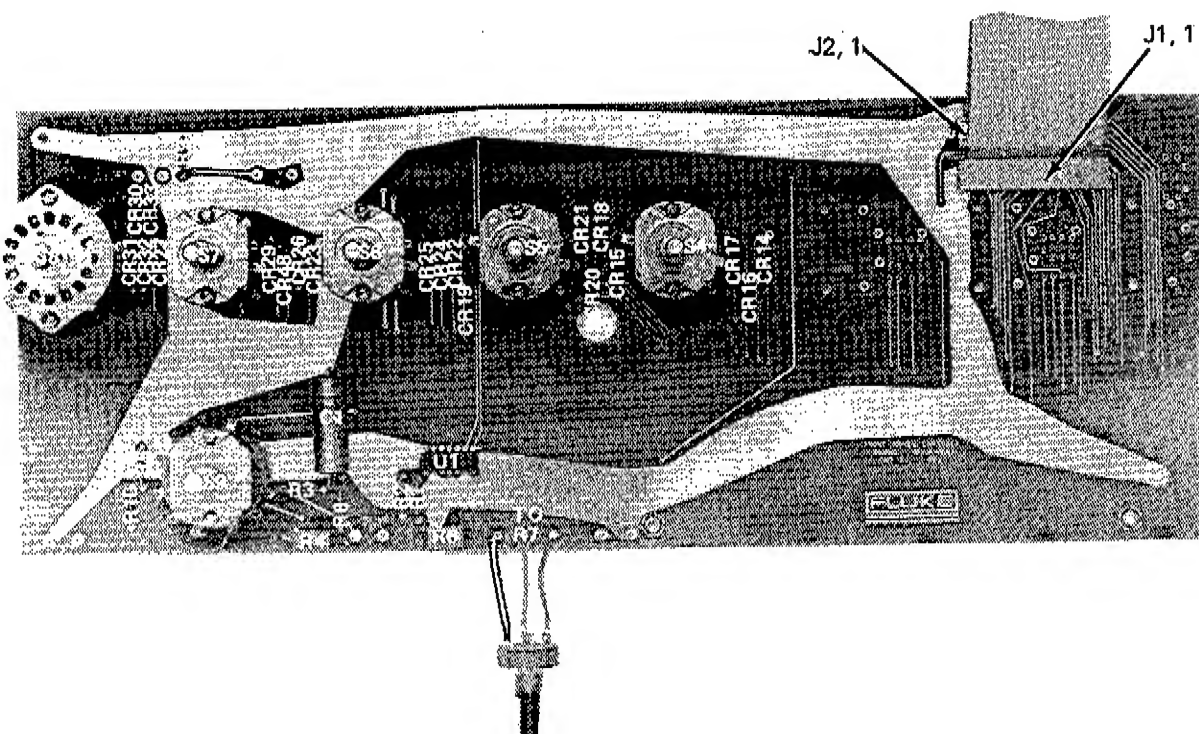


Figure 5-3. FRONT PANEL PCB ASSEMBLY, A1A1

10 MHz MAIN LOOP VCO MODULE ASSEMBLY, A2

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	10 MHz MAIN LOOP VCO MODULE ASSEMBLY Figure 5-4 6160A-4110	323741	89536	323741	REF		
A2A1	10 MHz Main Loop VCO PCB Assembly				1		
1	Module Cover, inner	323204	89536	323204	1		
2	Module cover, outer	323212	89536	323211	1		
3	Screw, 4 - 40 x 1/4 PNH - Phillips	129890	73734	19022	7		
4	Nameplate	329243	89536	329243	1		

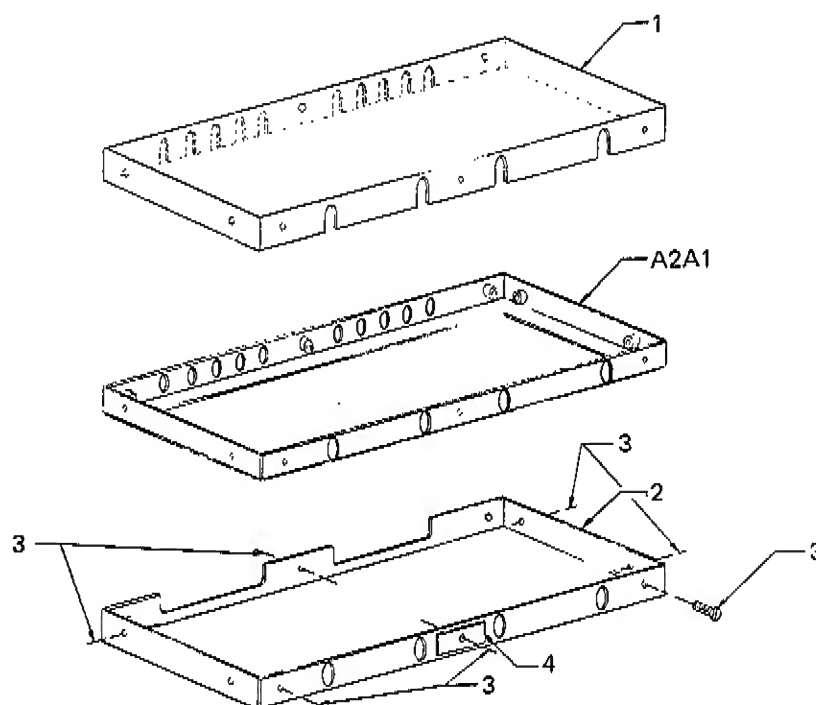


Figure 5-4. 10 MHz MAIN LOOP VCO MODULE ASSEMBLY, A2

10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2A1	10 MHz MAIN LOOP VCO PCB ASSEMBLY Figure 5-5 6160A-4010				REF		
C1 thru C5, C12, C15, C17	Cap, ta, 2.2 uf $\pm 20\%$, 20V	161927	56289	196D225X0020	8		
C6	Cap, plstc, 0.033 uf $\pm 10\%$, 50V	271841	06001	75F1R5A334	1		
C8	Cap, var cer, 4.5 to 50 pf + 70/-20%, 250V	321117	73899	DVJ305A	1		
C9	Cap, mica, 330 pf $\pm 1\%$, 500V	226142	53021	D15F331F	1		
C10	Cap, mica, 39 pf $\pm 5\%$, 500V	148544	53021	D15E390J	1		
C11	Cap, mica, 430 pf $\pm 5\%$, 500V	177980	53021	D15F431J	1		
C13, C16, C19	Cap, cer, 0.05 uf +80/-20%, 25V	148924	72982	5855-Y5U- 5032	3		
C14, C18	Cap, cer, 0.0012 uf $\pm 10\%$, 500V	106732	71590	CF-122	2		
C20, C21, C22	Cap, mica, 33 pf $\pm 5\%$, 500V	160317	53021	D15E330J	3		
C23 thru C28	Cap, feed thru, 2500 pf, 500V	248286	04222	BSF-188	6		
CR1, CR2, CR3, CR8 thru CR13	Diode, silicon, 150 mA	203323	03508	1N4148	9	2	
CR4 thru CR7	Diode, tuning,hyper abrupt	320200	KEV Elec- tronics	TYPE KV 2001	4	1	

10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
J1, J2 J4	Connector, male, coaxial	207639	13511	27 - 875	3		
L1, L2 L3, L11	Bead, 6 turn	320911	89536	320911	4		
L5	Inductor, 3.9 uh $\pm 10\%$, 815 mA	328054	24759	MR3.9	1		
L6	Bead, ferrite	219535	02114	56-060-85-3B	1		
L7	Inductor, 1 uh $\pm 10\%$, 2080 mA	320952	24759	MR1.0	1		
L8, L9 L10	Inductor	320903	89536	320903	3		
Q1, Q2, Q10 thru Q13	Tstr, silicon, NPN	218396	04713	2N3904	6	2	
Q3, Q4 Q9, Q14, Q15	Tstr, silicon, PNP	195974	04713	2N3906	5	1	
Q5, Q6, Q7, Q8	Tstr, silicon, NPN	248351	04713	MPS918	4	1	
R1	Res, comp, $39\Omega \pm 5\%$, $\frac{1}{4}W$	193391	01121	CB3905	1		
R2	Res, met flm, 4.99k 1%, 1/8W	168252	91637	MFF1- 84-991F	1		
R3, R38	Res, var, cermet, 2k $\pm 20\%$, $\frac{1}{2}W$	226076	19701	ET50W202	2		
R4	Res, comp, 6.8k $\pm 5\%$, $\frac{1}{4}W$	148098	01121	CB6825	1		
R5, R6	Res, met flm, 499 $\Omega \pm 1\%$, 1/8W	168211	91637	MFF1-84990F	2		
R7	Res, met flm, 6.49k $\pm 1\%$, 1/8W	294900	91637	MFF1-86-491F	1		
R8, R23	Res, comp, 2.7k $\pm 5\%$, $\frac{1}{4}W$	170720	01121	CB2725	2		
R9 R21, R42, R48	Res, comp, 100 $\Omega \pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	4		
R10, R11, R22	Res, comp, 2.2k $\pm 5\%$, $\frac{1}{4}W$	148049	01121	CB2225	3		

10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R12, R13, R25	Res, comp, $220\Omega \pm 5\%$, $\frac{1}{8}W$	147959	01121	CB2215	3		
R14, R16, R19, R20	Res, comp, $47\Omega \pm 10\%$, $\frac{1}{8}W$	272211	01121	BB4701	4		
R15	Res, comp, $10\Omega \pm 10\%$, $\frac{1}{8}W$	321125	01121	BB1001	1		
R17, R18	Res, comp, $470\Omega \pm 5\%$, $\frac{1}{4}W$	147983	01121	CB4715	2		
R24	Res, comp, $270\Omega \pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	1		
R26, R43, R44, R49	Res, comp, $12k \pm 5\%$, $\frac{1}{4}W$	159731	01121	CB1235	4		
R27	Res, met flm, $40.2k \pm 1\%$, $\frac{1}{8}W$	235333	91637	MFF1-840-22F	1		
R28	Res, met flm, $20k \pm 1\%$, $\frac{1}{8}W$	291872	91637	MFF1-82012F	1		
R29	Res, met flm, $10k \pm 1\%$, $\frac{1}{8}W$	168260	91637	MFF1-81012F	1		
R30, R31	Res, met flm, $8.06k \pm 1\%$, $\frac{1}{8}W$	294942	91637	MFF1-88061F	2		
R32, R37	Res, met flm, $4.22k \pm 1\%$, $\frac{1}{8}W$	168245	91637	MFF1-844221F	2		
R33	Res, var, cermet, $10k \pm 20\%$, $\frac{1}{2}W$	226092	80294	3329H-1-103	1		
R34, R39	Res, met flm, $24.9k \pm 1\%$, $\frac{1}{8}W$	291369	91637	MFF1-82592F	2		
R35	Res, met flm, $3.01k \pm 1\%$, $\frac{1}{8}W$	312645	91637	MFF1-83-011F	1		
R36	Res, var, cermet, $2k \pm 10\%$, $\frac{1}{2}W$	309666	11236	360T202A	1		
R40, R41	Res, met flm, $2k \pm 1\%$, $\frac{1}{8}W$	235226	91637	MFF1-82001F	2		
R45	Res, met flm, $1k \pm 1\%$, $\frac{1}{8}W$	168229	91637	MFF1-81001F	1		
R46	Res, met flm $23.2k \pm 1\%$, $\frac{1}{8}W$	291351	91637	MFF1-82322K	1		
R47	Res, comp, $15k \pm 5\%$, $\frac{1}{4}W$	148114	01121	CB1535	1		
U1,U2 U3	IC, Operational amplifier	271502	12040	LM301A	3		1
U4	IC, TTL, Hex inverter	292979	01295	3N7404N	1		1

10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

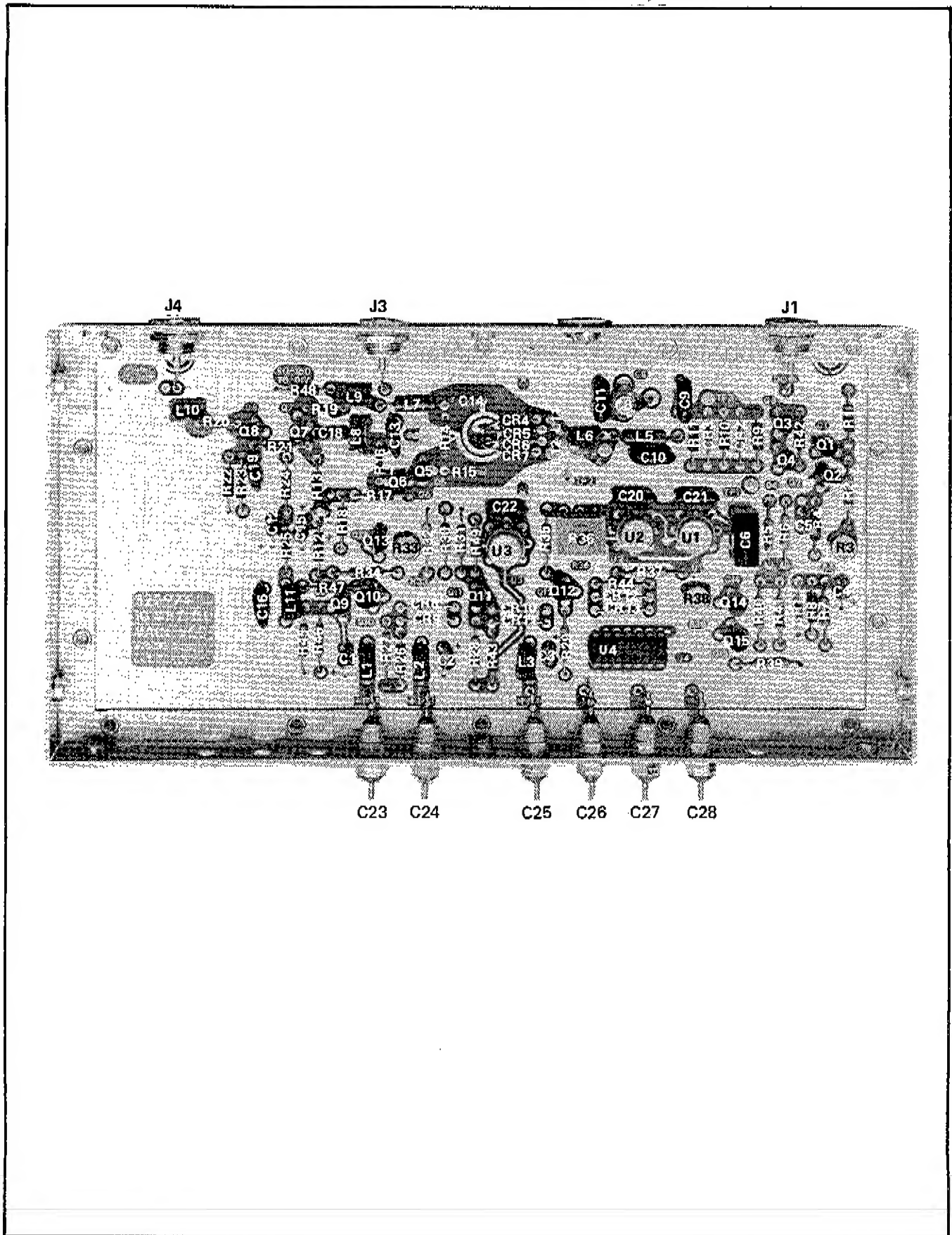


Figure 5-5. 10 MHz MAIN LOOP VCO PCB ASSEMBLY, A2A1

10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY, A3

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY Figure 5-6 6160A-4109	323733	89536	323733	REF		
A3A1	10 MHz Main Loop Phase Detector PCB Assembly Figure				1		
1	Module Cover, inner	323204	89536	323204	2		
2	Module Cover, outer	323212	89536	323212	1		
3	Screw, 4 - 40 x ¼, PNH - Phillips	129890	73734	19022	7		
4	Nameplate	329235	89536	329235	1		

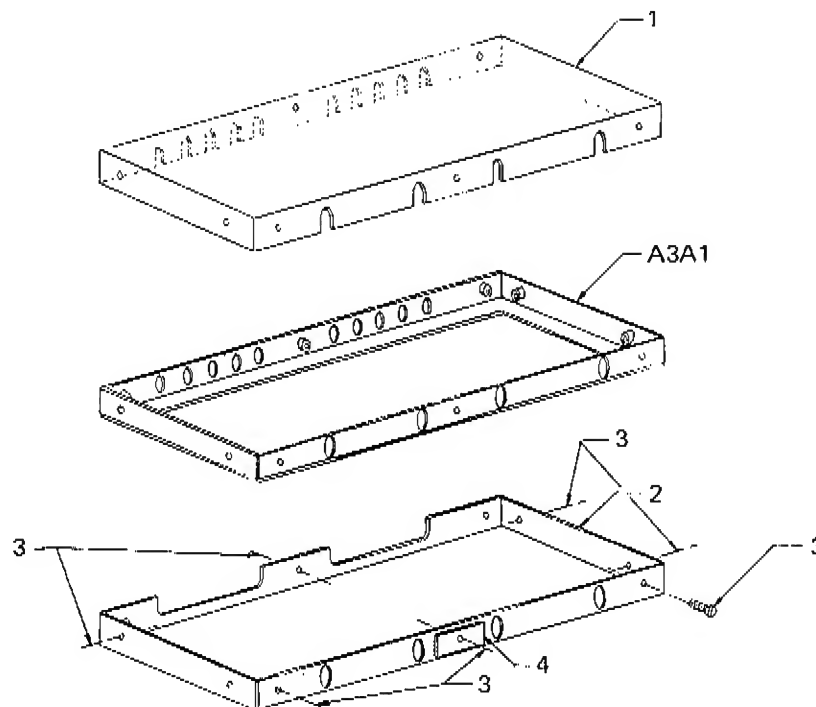


Figure 5-6 10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY

10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY, A3

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY Figure 5-6 6160A-4109	323733	89536	323733	REF		
A3A1	10 MHz Main Loop Phase Detector PCB Assembly Figure				1		
1	Module Cover, inner	323204	89536	323204	2		
2	Module Cover, outer	323212	89536	323212	1		
3	Screw, 4 - 40 x 1/4, PNH - Phillips	129890	73734	19022	7		
4	Nameplate	329235	89536	329235	1		

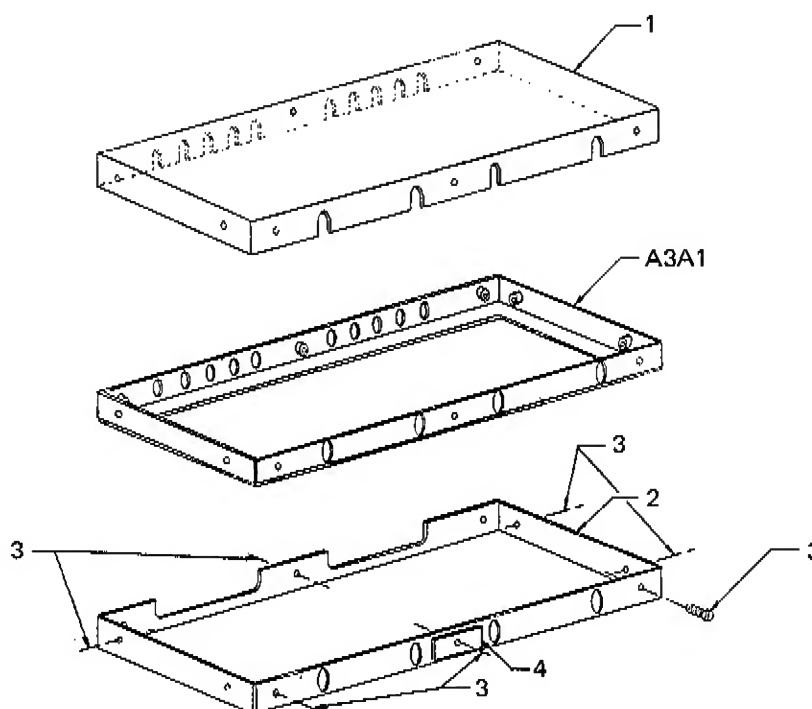


Figure 5-6 10 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY

10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3A1	10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY Figure 5-7 6160A-4009				REF		
C1, C2, C6 thru C12, C25, C26, C36 thru C39, C43	Cap, cer, 0.05 uf +80/-20%, 25V	148924	72982	5855-Y5U 5032	16		
C3, C4, C5, C28, C29, C41, C42	Cap, ta, 2.2 uf \pm 20%, 20V	161927	56289	196D225X 0020	6		
C13, C15, C16, C32, C33, C35	Cap, cer, 0.005 uf \pm 20%, 50V	255471	32897	8121-050- 651-005M	6		
C44 thru C47	Cap, feed-thru, 2500 pf, 500V	248286	04222	BSF1BB	4		
C14	Cap, cer, 7.5 pf \pm 0.25 pf, 500V	329961	04222	S1-1	1		
C17, C24, C31	Cap, mica, 220 pf \pm 5%, 500V	170423	53021	D15F221J	3		
C18, C20	Cap, mica, 82 pf \pm 5%, 500V	148502	53021	D15E820J	2		
C19	Cap, mica, 33 pf \pm 5%, 500V	160317	53021	D15E330J	1		
C21	Cap, mica, 330 pf \pm 5%, 500V	148445	53021	D15F331J	1		
C22	Cap, var, cer, 4.5 to 50 pf +70/-20%, 250V	321117	73899	DVJ 305A	1		
C23	Cap, mica, 39 pf \pm 5%, 500V	148544	53021	D15E390J	1		

10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C27, C40	Cap, cer, 0.0012 uf $\pm 10\%$, 500V	106732	71590	CF-122	2		
C30	Cap, mica, 18 pf $\pm 5\%$, 500V	266585	53021	D15C180J	1		
C34	Cap, var, 1 to 10 pf $\pm 20\%$, 250V	229930	73899	VAM010W	1		
CR1, CR6, CR7, CR13, CR14, CR20	Diode, hot carrier	313247	28480	5082-2811	6	2	
CR2 thru CR5, CR9 thru CR12	Diode, hot carrier	329623	28480	2833	8	2	
CR8, CR15 thru CR19, CR21	Diode, silicon, 150 mA	203323	03508	1N4148	7	2	
J1 thru J4	Conn, male, coaxial	207639	13511	27 - 875	4		
L1 thru L6, L10 thru L15	Bead, 6 turn	320911	89536	320911	12		
L7	Inductor, 0.15 uh $\pm 10\%$, 2600 mA	256297	24759	MR-0.15	1		
L8,L9	Inductor, 3.9 uh $\pm 10\%$, 815 mA	328054	24759	MR-3.9	2		
Q1 thru Q4, Q17,Q18	Tstr, silicon, PNP	226290	04713	MPS3640	6	2	

10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q5, Q6, Q15, Q16	Tstr, silicon, NPN	248351	04713	MPS918	4	1	
Q7	Tstr, silicon, PNP	195974	04713	2N3906	1	1	
Q8, Q9	Tstr, silicon, NPN	168716	07263	S19234	2	1	
Q10, Q11, Q14	Tstr, silicon, NPN	218396	04713	2N3904	3	1	
Q12, Q13	Tstr, silicon, PNP	225599	07263	S22650	2	1	
Q19	Tstr, J-FET, N-Channel	261578	89144	U2366E	1	1	
R1	Res, comp, $390\Omega \pm 5\%$, $\frac{1}{4}W$	147975	01121	CB3915	1		
R2, R3 R9, R55	Res, comp, $120\Omega \pm 5\%$, $\frac{1}{4}W$	170712	01121	CB1215	4		
R4, R5, R15	Res, comp, $3.3k \pm 5\%$, $\frac{1}{4}W$	148056	01121	CB3325	3		
R6, R7, R17, R34, R44, R45	Res, comp, $220\Omega \pm 5\%$, $\frac{1}{4}W$	147959	01121	CB2215	6		
R8, R11, R35, R41	Res, comp $82\Omega \pm 5\%$, $\frac{1}{4}W$	149484	01121	CB 8205	4		
R10, R39, R40, R53	Res, comp, $47\Omega \pm 5\%$, $\frac{1}{4}W$	147892	01121	CB4705	4		
R12, R14, R37, R42, R47, R51	Res, comp, $1k \pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	6		
R13, R54	Res, comp, $470\Omega \pm 5\%$, $\frac{1}{4}W$	147983	01121	CB4715	2		

10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R16	Res, comp, 15k \pm 5%, 1/4W	148114	01121	CB1535	1		
R18, R22	Res, comp, 2.2k \pm 5%, 1/4W	148049	01121	CB2225	2		
R19, R20, R36	Res, comp, 12k \pm 5%, 1/4W	159731	01121	CB1235	3		
R21	Res, comp, 1.8k \pm 5%, 1/4W	175042	01121	CB1825	1		
R23, R32	Res, comp, 6.8k \pm 5%, 1/4W	148098	01121	CB6825	2		
R24	Res, comp, 330k \pm 5%, 1/4W	192948	01121	CB3315	1		
R25, R30, R49	Res, comp, 8.2k \pm 5%, 1/4W	160796	01121	CB8225	3		
R26, R33	Res, comp, 4.7k \pm 5%, 1/4W	148072	01121	CB4725	2		
R27, R31	Res, met flm, 118k \pm 1%, 1/8W	291310	91637	MFF1-81183F	2		
R28	Res, met flm, 267k \pm 1%, 1/8W	289090	91637	MFF1-82673F	1		
R29	Res, var, cermet, 20k \pm 10%, 1/4W	291609	71450	360S-203A	1		
R38	Res, comp, 3.9k \pm 5%, 1/4W	148064	01121	CB3925	1		
R43	Res, comp, 56 Ω \pm 5%, 1/4W	147900	01121	CB5605	1		
R46	Res, comp, 18k \pm 5%, 1/4W	148122	01121	CB1835	1		
R48, R56	Res, comp, 120k \pm 5%, 1/4W	193458	01121	CB1245	2		
R50	Res, comp, 160 Ω \pm 5%, 1/4W	261859	01121	CB1615	1		
R52	Res, comp, 68k \pm 5%, 1/4W	148171	01121	CB6835	1		
T1 thru T5	Transformer, 8 turn	321067	89536	321067	5		
U1	Mixer, double balanced	320887	27956	M6K	1		
U2	IC, operational amplifier	329912	27014	LM318H	1	1	
U3, U4, U5	IC, operational amplifier	271502	12040	LM301A	3	1	

10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

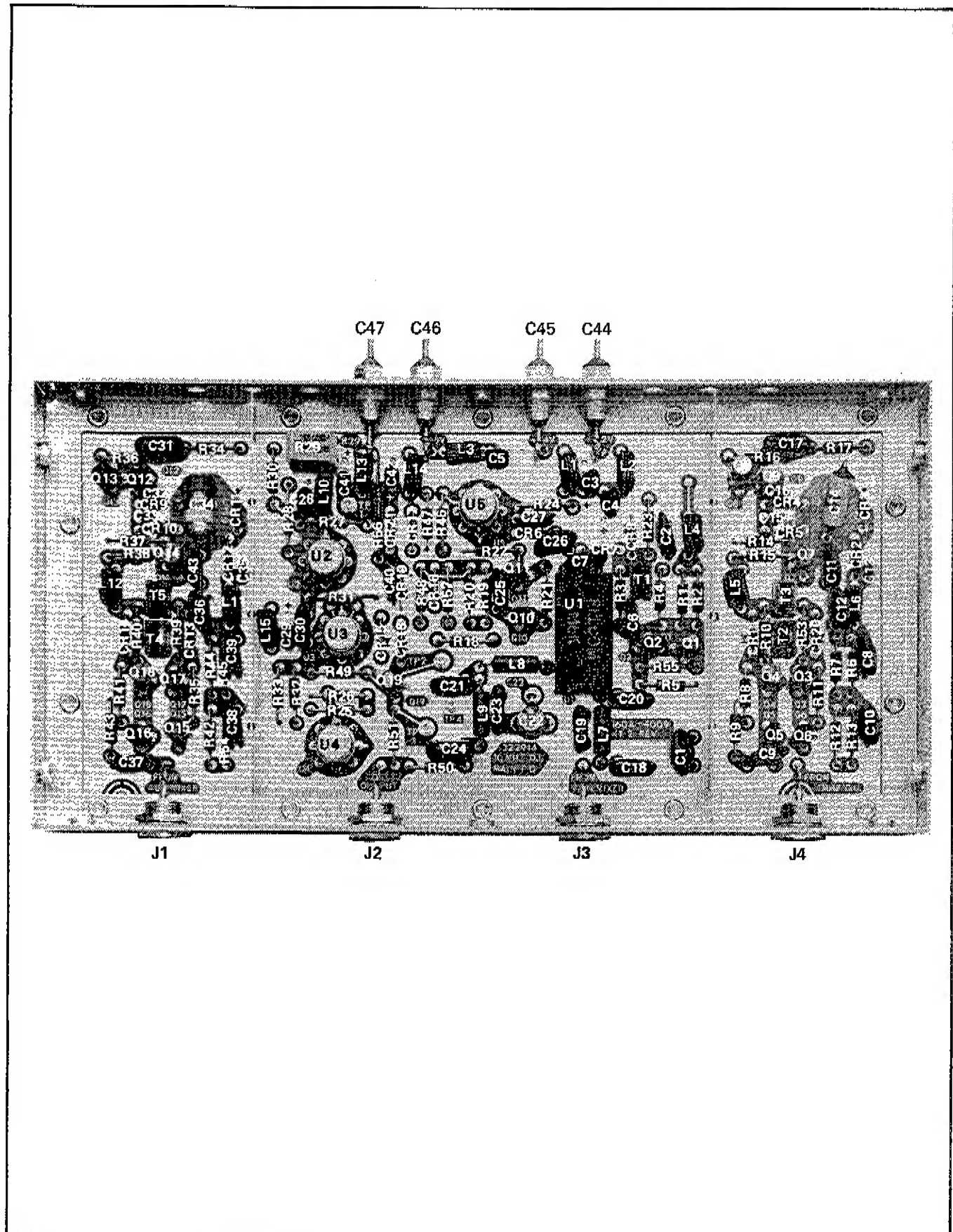


Figure 5-7. 10 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A3A1

10 MHz I. F. MIXER MODULE ASSEMBLY, A4

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A4	10 MHz I. F. MIXER MODULE ASSEMBLY Figure 5-8 6160A-4108	323725	89536	323725	REF		
A4A1	10 MHz I. F. Mixer PCB Assembly				1		
1	Module cover, inner	323204	89536	323204	1		
2	Module cover, outer	323212	89536	323212	1		
3	Screw, 4 - 40 x 1/4 PNH - Phillips	129890	73734	19022	7		
4	Nameplate	329227	89536	329227	1		

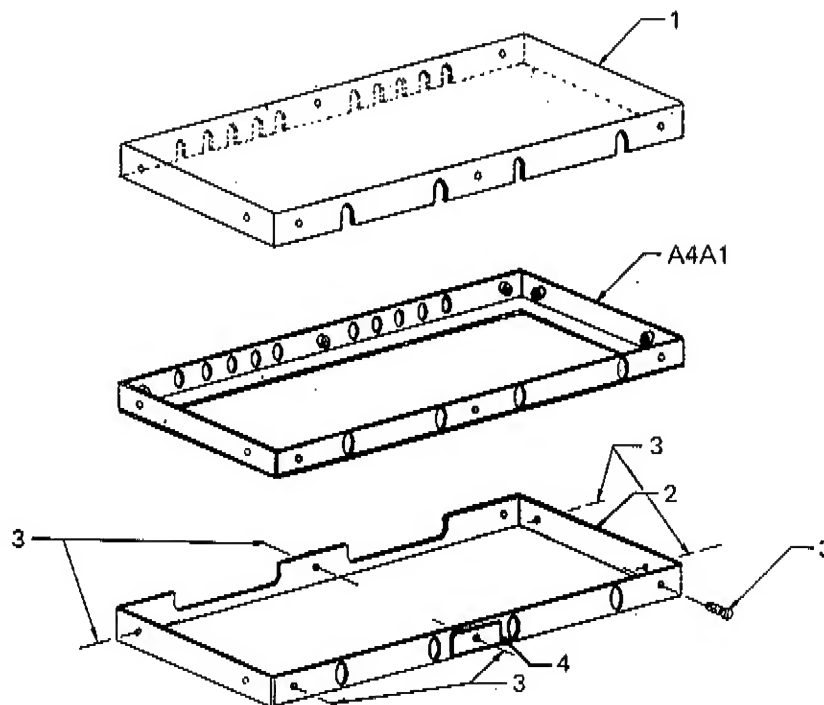


Figure 5-8. 10 MHz I.F. MIXER MODULE ASSEMBLY

10 MHz IF MIXER PCB ASSEMBLY, A4A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A4A1	10 MHz I.F. MIXER PCB ASSEMBLY Figure 5-9 6160A-4008				REF		
C1 C11, C34, C36, C39, C41, C43	Cap, cer, 0.05 uf +80/-20%, 25V	148924	72982	5855-Y5U- 5032	7		
C2, C12, C23, C24, C25, C29, C33	Cap, Ta, 2.2 uf \pm 20%, 20V	161927	56289	196D225X0020	7		
C3	Cap, cer, 0.005 uf \pm 20%, 50V	225471	32897	8121-050- 651-005M	1		
C4,C5 C13, C14, C15, C30, C31, C32, C35, C37, C40, C42	Cap, cer, 0.0012 uf \pm 10%, 500V	106732	71590	CF-122	12		
C6,C38	Cap, mica, 22 pf \pm 5%, 500V	148551	53021	D15220J	2		
C7	Cap, mica, 5.6 pf \pm 5%, 500V	329631	53021	D15C5-6J	1		
C8, C26	Cap, mica, 27 pf \pm 5%, 500V	177998	53021	D15E270J	2		
C9,C16	Cap, mica, 18 pf \pm 5%, 500V	266585	53021	D15C180J	2		
C10	Cap, mica, 15 pf \pm 5%, 500V	148569	53021	D15C150J	1		
C17	Cap, mica, 12 pf \pm 5%, 500V	175224	53021	D15E120J	1		
C18	Cap, mica, 100 pf \pm 5%, 500V	148494	53021	D15F101J	1		
C19	Cap, mica, 7.7 pf \pm 5%, 500V	329649	53021	D15C7-7J	1		

10 MHz IF MIXER PCB ASSEMBLY, A4A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C20	Cap, mica, 150 pf $\pm 5\%$, 500V	148478	53021	D15F151J	1		
C21	Cap, mica, 33 pf, $\pm 5\%$, 500V	160317	53021	D15E330J	1		
C27	Cap, mica, 130 pf $\pm 5\%$, 500V	266205	53021	D15F131J	1		
C28	Cap, mica 91 pf $\pm 5\%$, 500V	277228	53021	D15E910J	1		
C44 thru C46	Cap, feed-thru, 2500 pf, 500V	248286	04222	BSF-1BB	3		
CR1,CR2	Diode, hot carrier	313247	28480	5083-2811	2	1	
CR3	Diode, silicon, 150 mA	203323	03508	1N4148	1	1	
J1 thru J4	Connector, male, coaxial	207639	13511	27-875	4		
L1	Coil, 3-1/2, turn	332783	89536	332783	1		
L2	Coil, 1-1/2 turn	332775	89536	332775	1		
L3, L4, L10 thru L13, L17, L18, L19	Bead, 6 turn	320911	89536	320911	9		
L5,L9	Coil, 8 turn	332809	89536	332809	2		
L6	Coil, 1 turn	332767	89536	332767	1		
L7	Coil, 10 turn	332817	89536	332817	1		
L8	Coil, 5 turn	332791	89536	332791	1		
L14	Inductor, 0.47 uh $\pm 5\%$	329664	89536	329664	1		
L15, L16	Inductor, 0.39 uh	329656	89536	329656	2		
Q1, Q2, Q3	Tstr, silicon NPN	260638	25403	A485	3	1	

10 MHz IF MIXER PCB ASSEMBLY, A4A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q4	Tstr, silicon NPN	248351	04713	MPS918	1	1	
Q5, Q7, Q10	Tstr, silicon NPN	226290	04713	MPS3640	3	1	
Q6	Tstr, FET, N-Channel	288324	15818	U1994E	1	1	
Q8, Q9	Tstr, silicon NPN	195974	04713	2N 3906	2	1	
R1	Res, comp, $150\Omega \pm 5\%$, $\frac{1}{4}W$	147934	01121	CB1515	1		
R2, R3	Res, comp, $430\Omega \pm 5\%$, $\frac{1}{4}W$	203869	01121	CB4315	2		
R4, R22, R40 R41	Res, comp, $100\Omega \pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	4		
R5, R6	Res, comp, $47\Omega \pm 10\%$, $\frac{1}{8}W$	272211	01121	BB4701	2		
R7	Res, comp, $68\Omega \pm 5\%$, $\frac{1}{4}W$	147918	01121	CB6805	1		
R8	Res, comp, $470\Omega \pm 5\%$, $\frac{1}{4}W$	147983	01121	CB4715	1		
R9	Res, comp, $560\Omega \pm 5\%$, $\frac{1}{4}W$	147991	01121	CB5615	1		
R10	Res, comp, $270\Omega \pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	1		
R11	Res, comp $130\Omega \pm 5\%$, $\frac{1}{4}W$	325704	01121	CB1315	1		
R12	Res, comp, $75\Omega \pm 5\%$, $\frac{1}{4}W$	246736	01121	CB7505	1		
R13	Res, comp, $100\Omega \pm 10\%$, $\frac{1}{8}W$	261826	01121	BB1011	1		
R14, R16	Res, comp, $240\Omega \pm 5\%$, $\frac{1}{4}W$	221895	01121	CB2415	2		
R15	Res, comp, $43\Omega \pm 5\%$, $\frac{1}{4}W$	177162	01121	CB4305	1		
R17, R25	Res, comp $82\Omega \pm 5\%$, $\frac{1}{4}W$	149484	01121	CB8205	2		
R18, R37, R38	Res, comp, $2k \pm 5\%$, $\frac{1}{4}W$	202879	01121	CB2025	3		
R19, R24	Res, comp, $39\Omega \pm 5\%$, $\frac{1}{4}W$	193391	01121	CB3905	2		
R20	Res, comp, $22k \pm 5\%$, $\frac{1}{4}W$	148130	01121	CB2235	1		
R21, R39	Res, comp, $220\Omega \pm 5\%$, $\frac{1}{4}W$	147959	01121	CB2215	2		
R23, R27	Res, comp, $510\Omega \pm 5\%$, $\frac{1}{4}W$	218032	01121	CB5115	2		

10 MHz IF MIXER PCB ASSEMBLY, A4A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R26, R42	Res, comp, $390\Omega \pm 5\%$, $\frac{1}{4}W$	147975	01121	CB3915	2		
R28	Res, comp, $1.2k \pm 5\%$, $\frac{1}{4}W$	190371	01121	CB1225	1		
R29	Res, comp, $6.8k \pm 5\%$, $\frac{1}{4}W$	148098	01121	CB6825	1		
R30	Res, comp, $47k \pm 5\%$, $\frac{1}{4}W$	148163	01121	CB4735	1		
R31, R32	Res, comp, $750\Omega \pm 5\%$, $\frac{1}{4}W$	218024	01121	CB7515	2		
R33, R34	Res, comp, $12k \pm 5\%$, $\frac{1}{4}W$	159731	01121	CB1235	2		
R35	Res, var, cermet, $1k \pm 20\%$, $\frac{1}{4}W$	193060	80294	3329H-1-102	1		
R36	Res, comp, $910\Omega \pm 5\%$, $\frac{1}{4}W$	203851	01121	CB9115	1		
R43	Res, comp, $330\Omega \pm 5\%$, $\frac{1}{4}W$	147967	01121	CB3315	1		
T1, T2	Transformer	320903	89536	320903	2		
T3, T4	Transformer, 8 turn	321067	89536	321067	2		
U1	Mixer, double balance	248260	27956	M6F	1	1	

10 MHz IF MIXER PCB ASSEMBLY, A4A1

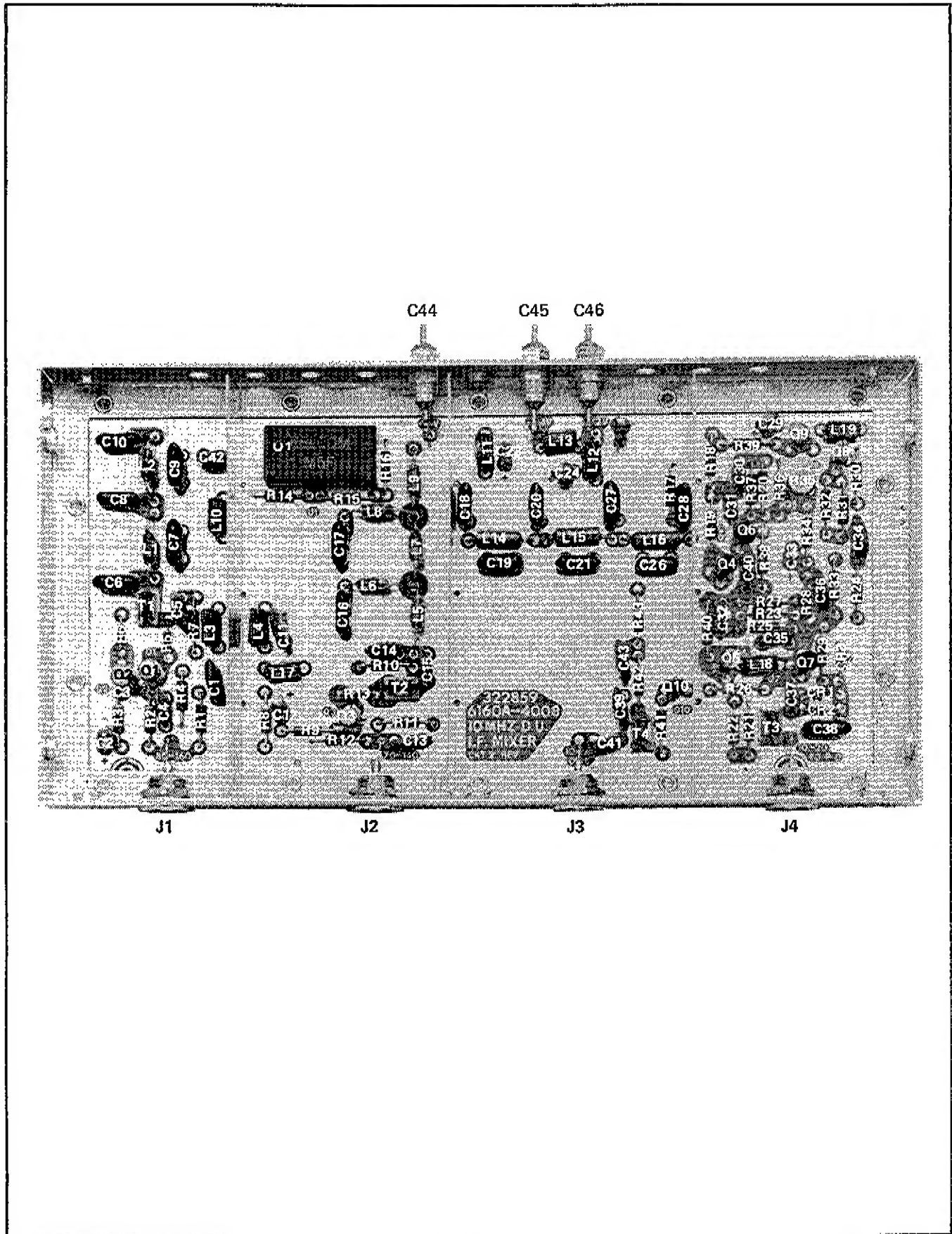


Figure 5-9. 10 MHz IF MIXER PCB ASSEMBLY, A4A1

10 MHz STEP LOOP VCO MODULE ASSEMBLY, A5

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5	10 MHz STEP LOOP VCO MODULE ASSEMBLY Figure 5-10 6160A-4107-1	341545	89536	341545	REF		
A5A1	10 MHz Step Loop VCO PCB Assembly				1		
1	Module Cover - inner	323204	89536	323204	1		
2	Module cover - outer	323212	89536	323212	1		
3	Screw, PNH - Phillips 4 - 40 X 1/4	129890	73734	19022	7		
4	Nameplate	329219	89536	329219	1		

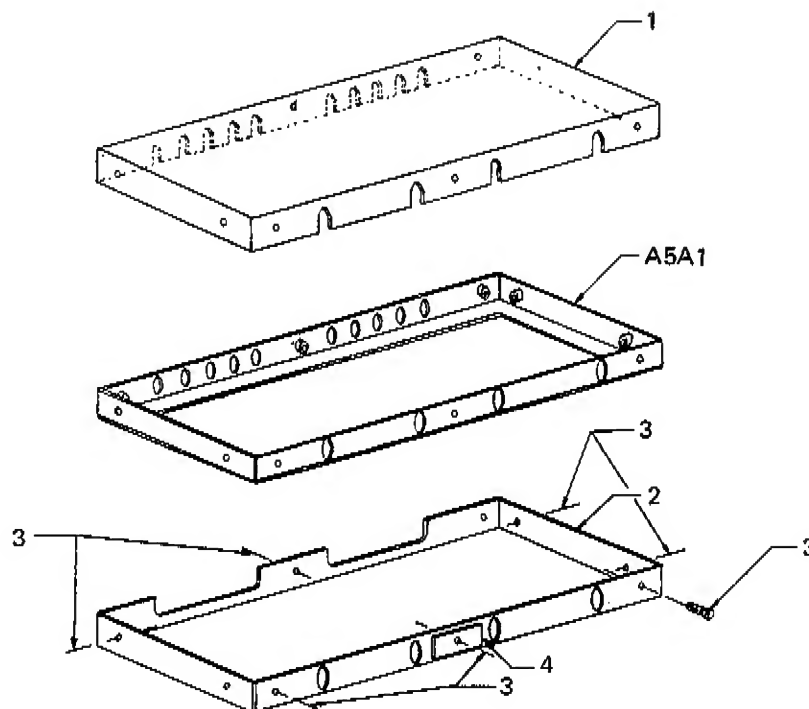


Figure 5-10. 10 MHz STEP LOOP VCO MODULE ASSEMBLY, A5

10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5A1	10 MHz STEP LOOP VCO PCB ASSEMBLY Figure 5-11 6160A-4007				REF		
C1	Cap, mica, 24.5 pf $\pm 2\%$, 500V	335620	53021	D15C24.5G	1		
C2	Cap, mica, 15 pf $\pm 2\%$, 500V	335612	53021	D15C150G	1		
C3	Cap, mica, 10 pf $\pm 2\%$, 500V	335638	53021	D15C100G	1		
C4	Cap, mica, 13.5 pf $\pm 2\%$, 500V	335646	53021	D15C13.5G	1		
C5 thru C9, C11, C14, C17, C26	Cap, Ta, 2.2 uf $\pm 20\%$, 20V	161927	56289	196D225X0020	9		
C10, C13, C15	Cap, cer, 0.05 uf $\pm 80/-20\%$, 25V	148924	72982	5855-Y5U-5032	3		
C12, C16	Cap, cer, 0.0012 uf $\pm 10\%$, 500V	106732	71590	CF-122	2		
C18, C22, C23	Cap, mica, 33 pf $\pm 5\%$, 500V	160317	53021	D15E330J	3		
C19	Cap, mica, 430 pf $\pm 5\%$, 500V	177980	53021	D15F431J	1		
C20	Cap, mica, 39 pf $\pm 5\%$, 500V	148544	53021	D15E390J	1		
C21	Cap, var, cer, 4.5 to 50 pf $\pm 70/-20\%$, 250V	321117	73899	DVJ305A	1		
C24	Cap, mica, 330 pf $\pm 5\%$, 500V	148445	53021	D15F331J	1		
C25	Cap, plstc, 0.033 uf $\pm 10\%$, 50V	271841	06001	75F1R5A334	1		
C27 thru C32	Cap, feed-thru, 2500 pf, 500V	248286	04222	BSF-1BB	6		
CR1, CR4	Diode, hot carrier, 1.0 pf, 32V	333906	28480	5082-2835	2	1	
CR2, CR3	Diode, pin, switching	334227	04713	MPN 3402	2	1	
CR5 thru CR8	Diode, tuning, hyper-abrupt	320200	KEV Elec- tronics	TYPE-KV2001	4	1	

10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR9 thru CR19	Diode, silicon, 150 mA	203323	03408	1N4148	11	1	
J1 thru J4	Connector, male, coaxial	207639	13511	27-875	4		
L1	Coil, 1 turn	332767	89536	332767	1		
L2	Coil, 5 turn	332791	89536	332791	1		
L3	Coil, 10 turn	332817	89536	332817	1		
L4, L5	Coil, 8 turn	332809	89536	332809	2		
L6 thru L11	Bead, 6 turn	320911	89536	320911	6		
L14	Bead, 1 turn	219535	02114	56-060-85-3B	1		
L15	Inductor, 3.9 uh	328054	24759	MR-3.9	1		
L16	Inductor, 1 uh	320952	24759	MR-1.0	1		
Q1, Q16, Q18	Tstr, silicon, NPN	218396	03713	2N 3904	3	1	
Q2, Q17, Q19, Q20, Q24	Tstr, silicon, PNP	195974	04713	2N 3906	5	1	
Q3 thru Q10, Q15	Tstr, silicon, NPN	242065	04713	2N 5089	9	2	
Q11 thru Q14	Tstr, silicon, NPN	248351	04713	MPS 918	4	1	
Q21, Q23	Tstr, silicon, PNP, dual	242016	11726	QD401-78E	2	1	
Q22	Tstr, silicon, NPN, dual	295717	11726	QD101-78E	1	1	

10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R1, R4, R5	Res, comp, $4.7k \pm 5\%$, $\frac{1}{4}W$	148072	01121	CB 4725	3		
R2, R3	Res, comp, $390\Omega \pm 5\%$, $\frac{1}{4}W$	147975	01121	CB 3915	2		
R6, R43	Res, comp, $12k \pm 5\%$, $\frac{1}{4}W$	159731	01121	CB1235	2		
R7	Res, comp, $10k \pm 5\%$, $\frac{1}{4}W$	148106	01121	CB 1035	1		
R8	Res, met flm, $28.7k \pm 1\%$, $1/8W$	235176	91637	MFF1-82872F	1		
R9	Res, met flm, $15.8k \pm 1\%$, $1/8W$	335398	91637	MFF1-81582F	1		
R10	Res, met flm, $16.5k \pm 1\%$, $1/8W$	335380	91637	MFF1-81652F	1		
R11	Res, met flm, $17.4k \pm 1\%$, $1/8W$	335372	91637	MFF1-81742F	1		
R12	Res, met flm, $22.1k \pm 1\%$, $1/8W$	335364	91637	MFF1-82212F	1		
R13	Res, met flm, $28.7k \pm 1\%$, $1/8W$	335315	91637	MFF1-82872F	1		
R14	Res, met flm, $38.3k \pm 1\%$, $1/8W$	235323	91637	MFF1-83832F	1		
R15	Res, met flm, $71.5k \pm 1\%$, $1/8W$	291435	91637	MFF1-87152F	1		
R16, R35, R40, R41, R46	Res, comp, $2.2k \pm 5\%$, $\frac{1}{4}W$	148049	91637	CB 2225	5		
R17	Res, comp, $2.7k \pm 5\%$, $\frac{1}{4}W$	170720	01121	CB 2725	1		
R18, R19, R24, R25	Res, comp, $47\Omega \pm 10\%$, $1/8W$	272211	01121	BB 4701	4		
R20, R56, R57	Res, comp, $100\Omega \pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	3		
R21	Res, comp, $270\Omega \pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	1		
R22, R26, R27	Res, comp, $220\Omega \pm 5\%$, $\frac{1}{4}W$	147959	01121	CB 2015	3		
R23	Res, comp, $68\Omega \pm 5\%$, $\frac{1}{4}W$	147918	01121	CB6805	1		
R28, R29	Res, comp, $470\Omega \pm 5\%$, $\frac{1}{4}W$	147983	01121	CB 4715	2		

10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R30	Res, comp, $10\Omega \pm 10\%$, 1/8 W	321125	01121	BB1001	1		
R31	Res, met flm, $9.09k \pm 1\%$, 1/8W	335406	91637	MFF1-89091F	1		
R32	Res, met flm, $115k \pm 1\%$, 1/8W	335356	91637	MFF1-81153F	1		
R33	Res, met flm, $12.7k \pm 1\%$, 1/8W	335349	91637	MFF1-81272F	1		
R34	Res, met flm, $13.3k \pm 1\%$, 1/8W	296566	91637	MFF1-81332F	1		
R36	Res, met flm, $1.07k \pm 1\%$, 1/8W	335448	91637	MFF1-81071F	1		
R37	Res, met flm, $11.3k \pm 1\%$, 1/8W	335414	91637	MFF1-81132F	1		
R38	Res, met flm, $1.54k \pm 1\%$, 1/8W	335331	91637	MFF1-81541F	1		
R39, R45	Res, comp, $15k \pm 5\%$, 1/4W	148114	01121	CB1525	1		
R42	Res, var, cermet, $500\Omega \pm 20\%$, 1/2W	226068	80294	3329H-1-501	1		
R44	Res, comp, $6.8k \pm 5\%$, 1/4W	148098	01121	CB6825	1		
R47, R48	Res, met flm, $2k \pm 1\%$, 1/8W	335422	91637	MFF1-82001F	2		
R49	Res, met flm, $26.1k \pm 1\%$, 1/8W	335430	91637	MFF1082612F	1		
R50	Res, met flm, $11.3k \pm 1\%$, 1/8W	293639	91637	MFF1-81132F	1		
R51, R52	Res, met flm, $1.21k \pm 1\%$, 1/8W	229146	91637	MFF1-81211F	2		
R53	Res, met flm, $34.8k \pm 1\%$, 1/8W	261487	91637	MFF1-83482F	1		
R54	Res, met flm, $121k \pm 1\%$, 1/8W	229369	91637	MFF1-81213F	1		
R55	Res, met flm, $22.1k \pm 1\%$, 1/8W	235234	91637	MFF1-82212F	1		
R58	Res, comp, $15\Omega \pm 10\%$, 1/8W	261800	01121	BB 1501	1		
R59	Res, met flm, $16.2k \pm 1\%$, 1/8W	226233	91637	MFF1-81622F	1		
R60	Res, var, cermet, $2k \pm 20\%$, 1/2W	226076	19701	ET50W202	1		
R70	Res, var, cermet, $1k \pm 20\%$, 1/4W	193060	80294	3329H - 1-102	1		
R80	Res, var, cermet, $50k \pm 10\%$, 1/2W	335778	71450	360T-502A	1		
R90	Res, var, cermet, $20k \pm 10\%$, 1/8W	335760	71450	360T-202A	1		
R100, R110, R120	Res, var, cermet, $10k \pm 10\%$, 1/2W	309674	71450	360T -102A	3		

10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R130, R140	Res, var, cermet, 5k \pm 10%, $\frac{1}{2}$ W	327569	71450	360T-502A	2		
T1, T2, T3	Transformer	320903	89536	320903	3		
U1, U3	IC, Operational amplifier	340067	07263	U5B7101392	1	1	
U2	IC, Operational amplifier	271502	12040	LM301A	2	1	
U4	IC, TTL, BCD to decimal decoders	293142	01295	SN7442N	1	1	

10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

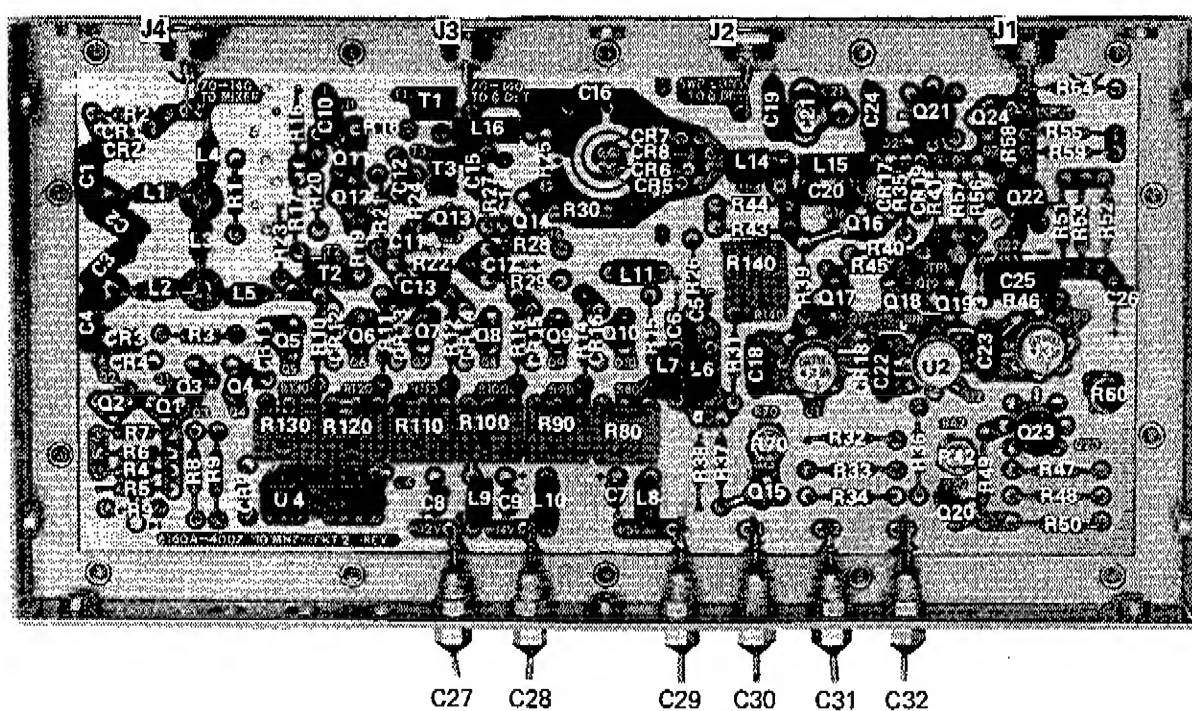


Figure 5-11. 10 MHz STEP LOOP VCO PCB ASSEMBLY, A5A1

10 MHz STEP LOOP PHASE DETECTOR MODULE ASSEMBLY, A6

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A6	10 MHz STEP LOOP PHASE DETECTOR MODULE ASSEMBLY Figure 5-12 6160A-4106-1	341537	89536	341537	REF		
A6A1	10 MHz Step Loop Phase Detector PCB Assembly 6160A-4006				1		
1	Module Cover - inner	323204	89536	323204	1		
2	Module Cover - outer	323212	89536	323212	1		
3	Screw, PNH - Phillips. 4-40 X 1/4	129890	73734	19022	7		
4	Nameplate	329201	89536	329201	1		

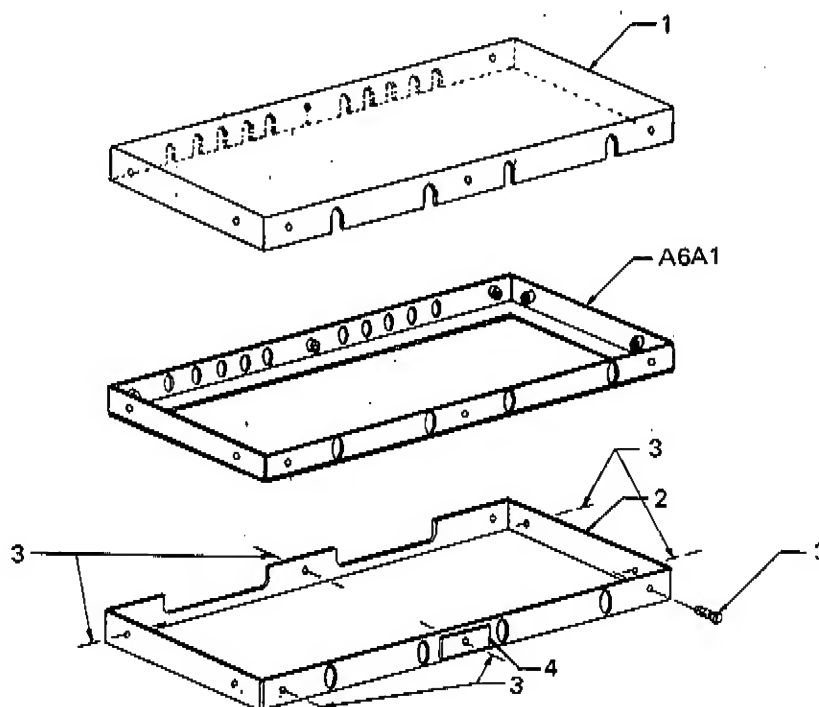


Figure 5-12. 10 MHz STEP LOOP PHASE DETECTOR MODULE ASSEMBLY, A6

10 MHZ STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A6A1	10 MHZ STEP LOOP PHASE DETECTOR PCB ASSEMBLY Figure 5-13 6160A-4006				REF		
C1,C5, C6, C18, C19, C24, C26, C27, C28	Cap, cer, 0.05 uf +80/-20%, 25V	148924	72984	5855-YSU-5032	9		
C2, C23, C40, C41, C42	Cap, Ta, 2.2 uf \pm 20%, 20V	161927	56289	196D225X0020	5		
C3, C12, C29, C35	Cap, cer, 0.0012 uf \pm 10%, 500V	106732	71590	CF-122	4		
C4	Cap, cer, 0.005 uf \pm 20%, 500V	255471	32897	8121-050-651- 005M	1		
C7	Cap, mica, 22 pf \pm 5%, 500V	148551	53021	D15E220J	1		
C8	Cap, mica, 56 pf \pm 5%, 500V	329631	53021	D15C560F	1		
C9, C31, C34	Cap, mica, 27 pf \pm 5%, 500V	177998	53021	D15E270J	3		
C10	Cap, mica, 18 pf \pm 5%, 500V	266585	53021	D15C180J	1		
C11, C22	Cap, mica, 15 pf \pm 5%, 500V	148569	53021	D15C150J	2		
C13	Cap, var, cer, 4.5 to 50 pf+70/-20%,250V	321117	73899	DVJ 305A	1		
C14	Cap, mica, 39 pf \pm 5%, 500V	148544	53021	D15E 390J	1		
C15	Cap, mica, 330 pf \pm 5%, 500V	148445	53021	D15F 331J	1		
C16	Cap, mica, 220 pf \pm 5%, 500V	170423	53021	D15F 221J	1		
C17	Cap, cer, 0.01 uf +80/-20%, 25/50V	335786	32897	5835-000- YSU - 1032	1		
C20, C21, C25	Cap, mica, 430 pf \pm 5%, 500V	177980	53021	D15F 431J	3		

10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C30	Cap, mica, 2 pf ± 0.05 pf	175208	53021	D15C020D	1		
C32	Cap, Ta, 10 uf $\pm 20\%$, 10V	176214	56289	196D106X001	1		
C33	Cap, mica, 51 pf $\pm 2\%$, 500V	335810	53021	D15E510G	1		
C36	Cap, mica, 15 pf $\pm 2\%$, 500V	335612	53021	D15C150G	1		
C37	Cap, mica, 24.5 pf $\pm 2\%$, 500V	335620	53021	D15C24.5G	1		
C38	Cap, mica, 10 pf $\pm 2\%$, 500V	335638	53021	D15C100G	1		
C39	Cap, mica, 13.5 pf $\pm 2\%$, 500V	335656	53021	D15C13.5G	1		
C41 thru C45	Cap, feed-thru, 2500 pf, 500V	248286	04222	BSF-1BB	4		
CR1, CR9, CR10, CR12 thru CR17, CR19, CR20	Diode, silicon, 150 mA	203323	03508	1N4148	11	1	
CR2, CR3	Diode, hot carrier, 1.2 pf, 0.41V	313247	28480	5082-2811	2	1	
CR4, CR6, CR18	Diode, hot carrier, 1.0 pf, .32V	333906	28480	5082-2835	3	1	
CR5, CR7, CR8	Diode, pin, silicon, switching	334227	04713	MPN3402	3	1	
CR11	Diode, step recovery	335588	28480	5082-0180	1	1	
J1 thru J4	Connector, male, coaxial	207639	13511	27-875	4		
L1	Coil, assy, VHF, 1 turn	332767	89536	332767	1		
L2	Coil, assy, VHF, 5 turn	332791	89536	332791	1		
L3,L4 L5, L13, L14, L15, L17, L18, L19	Inductor, 6 turn beads	320911	89536	320911	9		

10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
L6	Coil, assy, VHF, .3 1/2 turn	332783	89536	332783	1		
L7	Coil, assy, VHF, 1 1/2 turn	332775	89536	332775	1		
L8, L10, L20	Coil, assy, VHF, 8 turn	332809	89536	332809	3		
L9, L11	Coil, assy, VHF, 10 turn	332817	89536	332817	2		
L12, L21	Inductor, 3.9 uh $\pm 10\%$, 815 mA	328054	24759	MR-3.9	2		
L16	Inductor, 0.27 uh $\pm 10\%$, 1625 mA	313031	24759	MR-0.27	1		
L22	Inductor, 0.47 uh $\pm 10\%$, 1060 mA	320929	24759	MR-0.47	1		
Q1, Q2	Tstr, silicon, NPN	260638	25403	A485	2	1	
Q3, Q6, Q7, Q15, Q16	Tstr, silicon, NPN	195974	04713	2N 3906	5	1	
Q4, Q8, Q9, Q12, Q13, Q14	Tstr, silicon, NPN	218396	04713	2N3904	6	2	
Q5	Tstr, silicon, NPN	242065	04713	2N5089	1	1	
Q10, Q11	Tstr, silicon, NPN	179374	07269	2N2218	2	1	
R1	Res, comp, 150 Ω $\pm 5\%$, 1/4W	147934	01121	CB1515	1		
R2,R3	Res, comp, 430 Ω $\pm 5\%$, 1/4W	203869	01121	CB4315	2		
R4, R35	Res, comp, 100 Ω $\pm 5\%$, 1/4W	147926	01121	CB1015	2		
R5,R7, R32, R33	Res, comp, 47 Ω $\pm 10\%$, 1/8W	272211	01121	BB4701	4		
R6	Res, comp, 68 Ω $\pm 5\%$, 1/4W	147918	01121	CB6805	1		

10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R6	Res, comp, $68\Omega \pm 5\%$, $\frac{1}{4}W$	147918	01121	CB6805	1		
R8, R13, R56	Res, comp, $1k \pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	3		
R9, R14, R18, R42, R52	Res, comp, $6.8k \pm 5\%$, $\frac{1}{4}W$	148098	01121	CB6825	5		
R10, R12	Res, comp, $220\Omega \pm 5\%$, $\frac{1}{4}W$	147959	01121	CB2215	2		
R11	Res, comp, $1.8k \pm 5\%$, $\frac{1}{4}W$	175042	01121	CB1825	1		
R15	Res, comp, $5.6k \pm 5\%$, $\frac{1}{4}W$	148080	01121	CB5625	1		
R16, R24, R57	Res, comp, $3.3k \pm 5\%$, $\frac{1}{4}W$	148056	01121	CB3325	3		
R17	Res, comp, $15k \pm 5\%$, $\frac{1}{4}W$	234682	01121	CB1535	1		
R19	Res, comp, $56k \pm 5\%$, $\frac{1}{4}W$	170738	01121	CB5635	1		
R20	Res, met flm, $37.4k \pm 1\%$, $1/8W$	226241	91637	MFF1-83742F	1		
R21	Res, met flm, $10k \pm 1\%$, $1/8W$	168260	91637	MFF1-81002F	1		
R22	Res, met flm, $40.2k \pm 1\%$, $1/8W$	235333	91637	MFF1-84022F	1		
R23	Res, met flm, $97.6k \pm 1\%$, $1/8W$	241380	91637	MFF1-89762F	1		
R25, R26	Res, comp, $1.5k \pm 5\%$, $\frac{1}{4}W$	148031	01121	CB1525	2		
R27, R34	Res, var, cermet, $200\Omega \pm 20\%$, $\frac{1}{2}W$	226050	80294	3329H-1-201	2		
R28, R41	Res, comp, $130\Omega \pm 5\%$, $\frac{1}{4}W$	325704	01121	CB1315	2		
R29, R30	Res, comp, $820\Omega \pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	2		
R31	Res, comp, $91\Omega \pm 5\%$, $\frac{1}{4}W$	221887	01121	CB9105	1		
R36	Res, comp, $10\Omega \pm 5\%$, $\frac{1}{4}W$	147868	01121	CB1005	1		
R37	Res, comp $270\Omega \pm 10\%$, $1/8W$	261834	01121	BB2711	1		
R38	Res, comp, $270\Omega \pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	1		

10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R39	Res, comp, $180\Omega \pm 5\%$, $\frac{1}{4}W$	147942	01121	CB1815	1		
R40	Res, comp, $43\Omega \pm 5\%$, $\frac{1}{4}W$	177162	01121	CB4305	1		
R43, R50 R51	Res, comp, $390\Omega \pm 5\%$, $\frac{1}{4}W$	147975	01121	CB3915	1		
R44, R45	Res, comp, $10k \pm 5\%$, $\frac{1}{4}W$	148106	01121	CB1005	2		
R46	Res, comp, $2.2k \pm 5\%$, $\frac{1}{4}W$	148049	01121	CB2225	1		
R47, R48	Res, comp, $4.7k \pm 5\%$, $\frac{1}{4}W$	148072	01121	CB4725	2		
R49	Res, comp, $12k \pm 5\%$, $\frac{1}{4}W$	159731	01121	CB1235	1		
R53	Res, comp, $51\Omega \pm 5\%$, $\frac{1}{4}W$	221879	01121	CB5105	1		
R54	REs, comp, $110\Omega \pm 5\%$, $\frac{1}{4}W$	193474	01121	CB1115	1		
R55	Res, comp, $15k \pm 5\%$, $\frac{1}{4}W$	148114	01121	CB1535	1		
R60	Res, comp, $100\Omega \pm 10\%$, $1/8W$	261826	01121	BB1011	1		
T1, T2, T3	Transformer	320903	89536	320903	3		
T4	Transformer	338905	89536	338903	1		
U1	IC, TTL, Qua 2-Input Nand Gate	292953	01295	SN7400N	1	1	
U2	IC, Operational amplifier	271502	12040	LM301A	1	1	
U3	IC, mixer, double balance, ring modulator	248260	27956	M6F	1	1	

10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

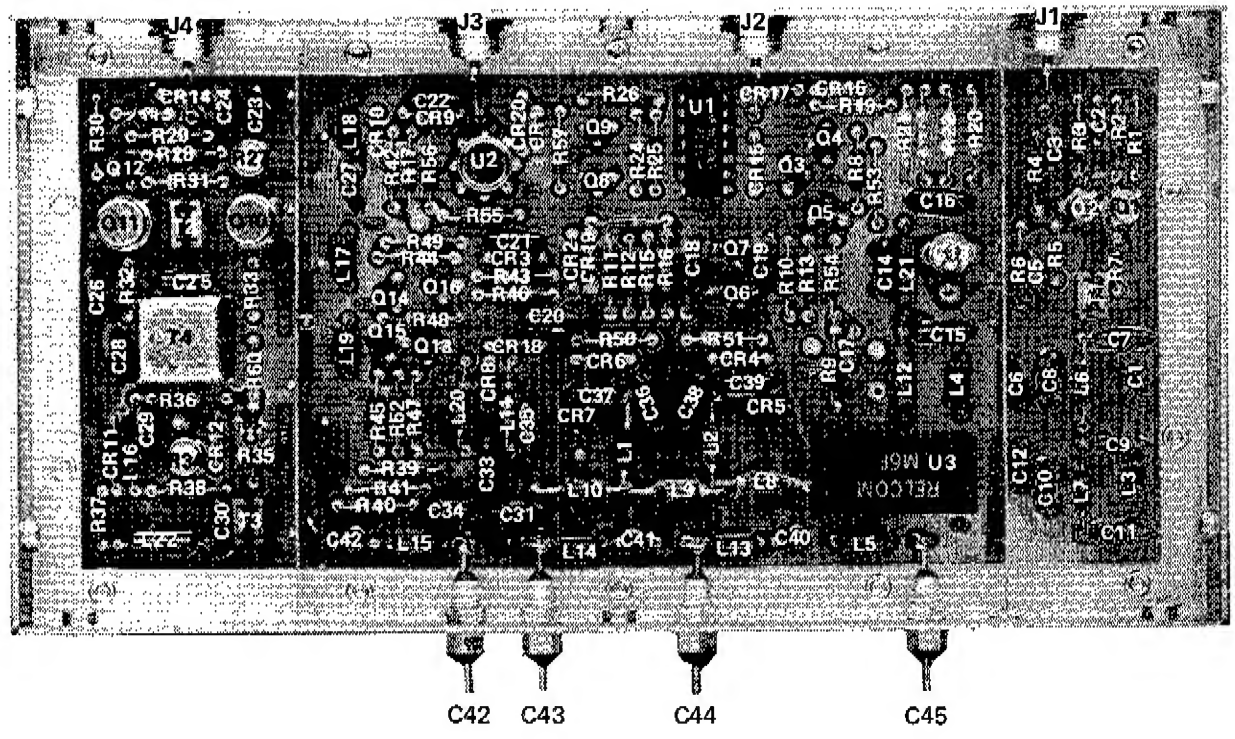


Figure 5-13. 10 MHz STEP LOOP PHASE DETECTOR PCB ASSEMBLY, A6A1

INPUT FILTER MODULE ASSEMBLY, A7

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A7	INPUT FILTER MODULE ASSEMBLY Figure 5-14 6160A-4101	323667	89536	323667	REF		
A7A1	Input Filter PCB Assembly				1		
1	Module Cover, inner	323204	89536	323204	1		
2	Module cover, outer	323212	89536	323212	1		
3	Screw, PNH, Phillips 4 - 40 x ¼	129890	73734	19022	7		
4	Nameplate	329769	89536	329769	1		

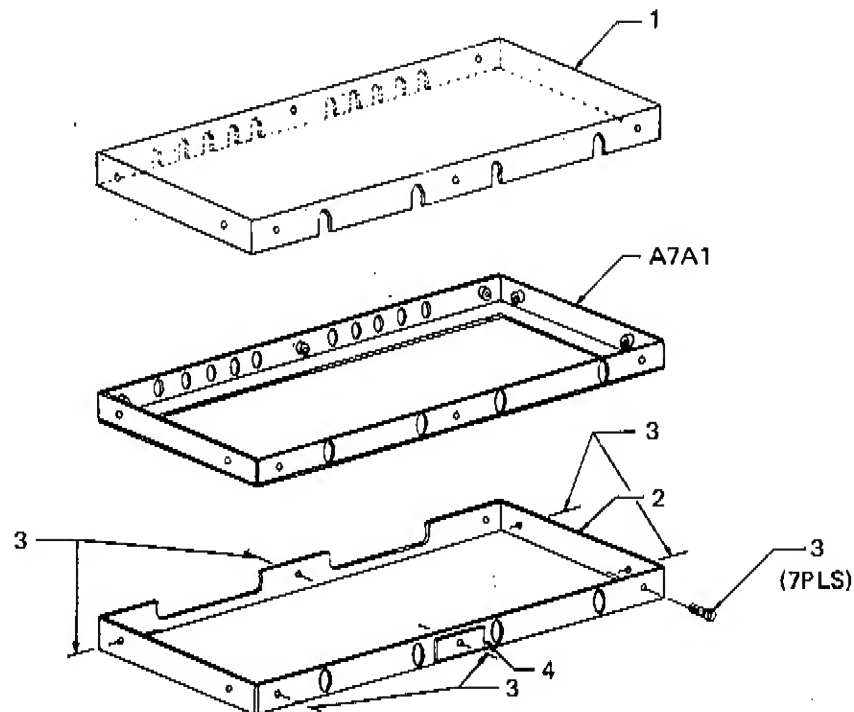


Figure 5-14. INPUT FILTER MODULE ASSEMBLY, A7

INPUT FILTER PCB ASSEMBLY, A7A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A7A1	INPUT FILTER PCB ASSEMBLY Figure 5-15 6160A-4001				REF		
C1,C2 C3,C6, C7,C8, C11, C13, C16, C18, C21, C22, C25 thru C28	Cap, cer, 0.05 uf +80/-20%, 25V	148924	72982	5855-&5U-5032	16		
C29 thru C31	Cap, feed-thru, 2500 pf, 500V	248286	04222	BSF-1BB	3		
C4	Cap, mica, 510 pf $\pm 5\%$, 500V	148411	53021	CD15E511J	1		
C5	Cap, mica, 150 pf $\pm 5\%$, 500V	148478	53021	CD15F151J	1		
C10, C14, C19	Cap, mica, 220 pf $\pm 5\%$, 500V	170423	53021	CD15F221J	3		
C12, C17	Cap, mica, 560 pf $\pm 5\%$, 500V	170431	53021	CD19F561J	2		
C20	Cap, mica, 1000 pf $\pm 5\%$, 500V	148387	53021	CD19F102J	1		
C23	Cap, mica, 1500 pf $\pm 5\%$, 500V	148361	53021	CD19F152J	1		
C24	Cap, mica, 390 pf $\pm 5\%$, 500V	148437	53021	CD15F391J	1		
CR1	Diode, silicon, 150 mA	203323	03508	1N4148	1	1	
CR2, CR3	Diode, germanium, 80 mA, 100 piv	149187	93332	1N270	2	1	
J1 thru J4	Connector, male, coaxial	207639	13511	27-875	4		
L1	Inductor, 0.75 uh	204891	89536	204891	1		
L2	Coil	173013	89536	173013	1		
L3,L4 L7	Inductor, 1000 uh $\pm 10\%$, 40 mA	256107	24759	MR-1000	3		

INPUT FILTER PCB ASSEMBLY, A7A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
L5	Inductor, 3.3 uh $\pm 5\%$, 1030 mA	174714	72259	WEE 3-3	1		
L6	Bead,	219535	02114	56-060-85-38	1		
Q1,Q2	Tstr, silicon, NPN	246264	95303	2N3933	2	1	
Q3 thru Q7	Tstr, silicon, NPN	179374	07263	2N2218	5	1	
R1, R6	Res, comp, 51 Ω $\pm 5\%$, 1/4W	221879	01121	CB5105	2		
R2, R14, R23	Res, comp, 8.2k $\pm 5\%$, 1/4W	160796	01121	CB8225	3		
R3, R12	Res, comp, 1k $\pm 5\%$, 1/4W	148025	01121	CB1025	2		
R4, R5, R18	Res, comp, 270 Ω $\pm 5\%$, 1/4W	160804	01121	CB2715	3		
R7	Res, comp, 3.3k $\pm 5\%$, 1/4W	148056	01121	CB3325	1		
R8	Res, var, cermet, 5k $\pm 20\%$, 1/2W	226084	80294	3329H-1-502	1		
R9, R15	Res, comp, 5.6k $\pm 5\%$, 1/4W	148080	01121	CB5625	2		
R10	Res, comp, 180 Ω $\pm 5\%$, 1/4W	147942	01121	CB 1815	1		
R11	Res, comp, 33 Ω $\pm 5\%$, 1/4W	175034	01121	CB3305			
R13	Res, comp, 680 Ω $\pm 5\%$, 1/4W	148007	01121	CB6815	1		
R16	Res, comp, 39 Ω $\pm 5\%$, 1/4W	193391	01121	CB3905	1		
R17	Res, var, cermet, 100 Ω	193052	80294	3329H-1-101	1		
R19, R28	Res, comp, 4.7k $\pm 5\%$, 1/4W	148072	01121	CB4725	2		
R20, R21	Res, comp, 12k $\pm 5\%$, 1/4W	159731	01121	CB1235	2		
R22	Res, comp, 220 Ω $\pm 5\%$, 1/4W	147959	01121	CB2215	1		
R24, R26, R31	Res, comp, 100 Ω $\pm 5\%$, 1/4W	147926	01121	CB1015	3		
R25	Res, var, cermet, 200 Ω $\pm 10\%$, 1/4W	226050	01121	CB2015	1		

INPUT FILTER PCB ASSEMBLY, A7A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R29	Res, comp, $330\Omega \pm 5\%$, $\frac{1}{4}W$	147967	01121	CB3315	1		
R30	Res, comp, $560\Omega \pm 5\%$, $\frac{1}{4}W$	147991	01121	CB5615	1		
R32	Res, comp, $2k \pm 5\%$, $\frac{1}{4}W$	202879	01121	CB2025	1		
R33	Res, comp, $150\Omega \pm 5\%$, $\frac{1}{4}W$	147934	01121	CB1515	1		
T1,T2	Transformer, var, nom, 2.5 uh	254201	89536	254201	2		
T3	Transformer, 4.2 uh	173021	89536	173021	1		
U1	IC, TTL, Quad 2-Input Nand Gate	292953	01295	SN7400N	1	1	
Y1, Y2	Crystal, 5 MHz	255927	71450	H17-019-0589	2		
	Holder, crystal	148668	91506	8000-AG-10	2		
	Socket, IC, 14 contact	276527	23880	TSA-2900-14W	2		
	Spacer, Xstr mtg. Pad T 0-5	152207	Milton Ross	10123-DAP	5		

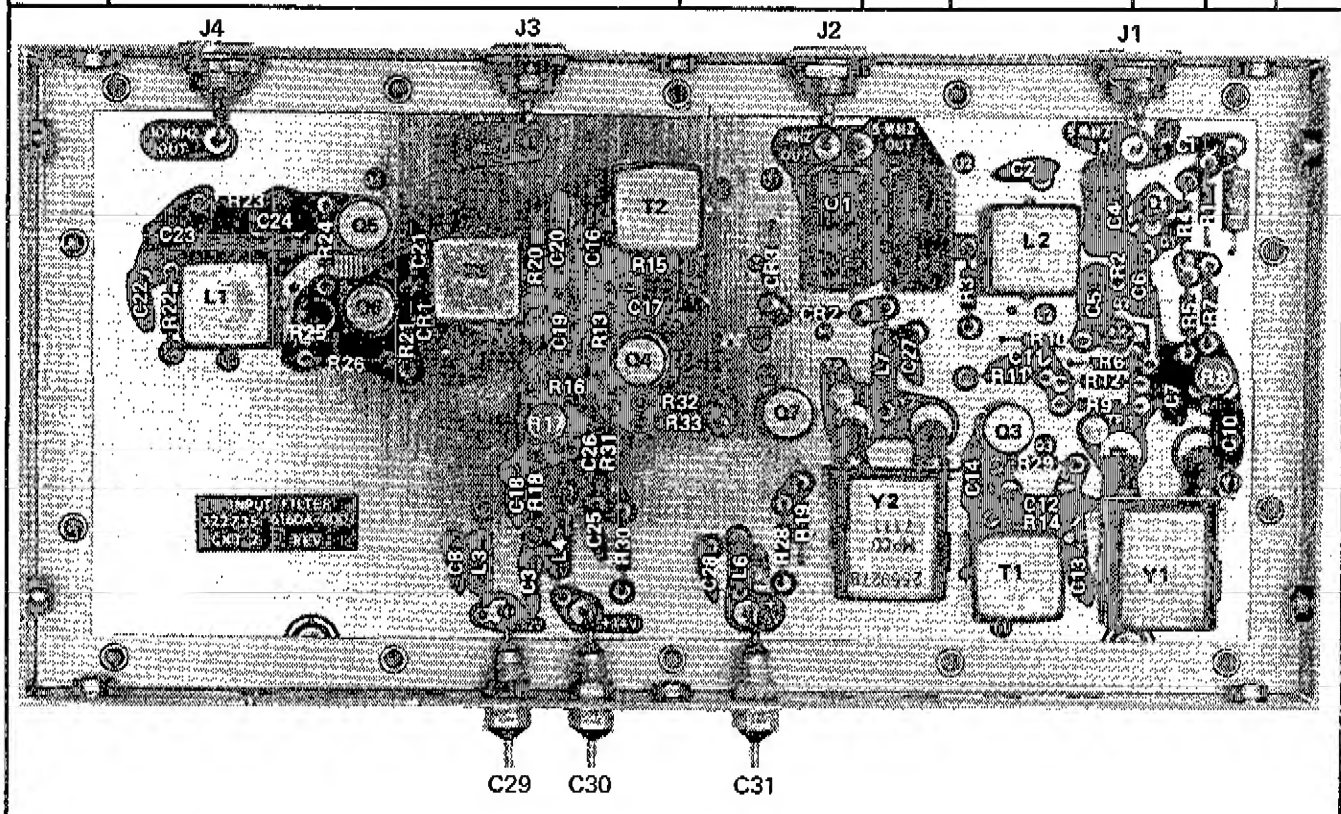


Figure 5-15. INPUT FILTER PCB ASSEMBLY, A7A1

1 MHz DIGIT GENERATOR MODULE SET ASSEMBLY, A8

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8	1 MHz DIGIT GENERATOR MODULE SET ASSEMBLY Figure 5-16 6160B-4153	356444	89536	356444	REF		
A8A1	1 MHz Digit Matched Module Pair Assembly - 6160B-4153-1 and -2				1		
A8A2	Main Loop Phase Detector Module Assembly - 6160B-4153-3				1		
1	Joiner, module set	356469	89536	356469	2		
2	Screw, 4 - 40 x 1/4 PNH Phillips	129890	73734	19022	6		

NOTE

A8A1 and A8A2 comprise a module set, and are procurable only as a complete and tested assembly. Also note that A8A1 comprises two separate, but electrically matched, modules.

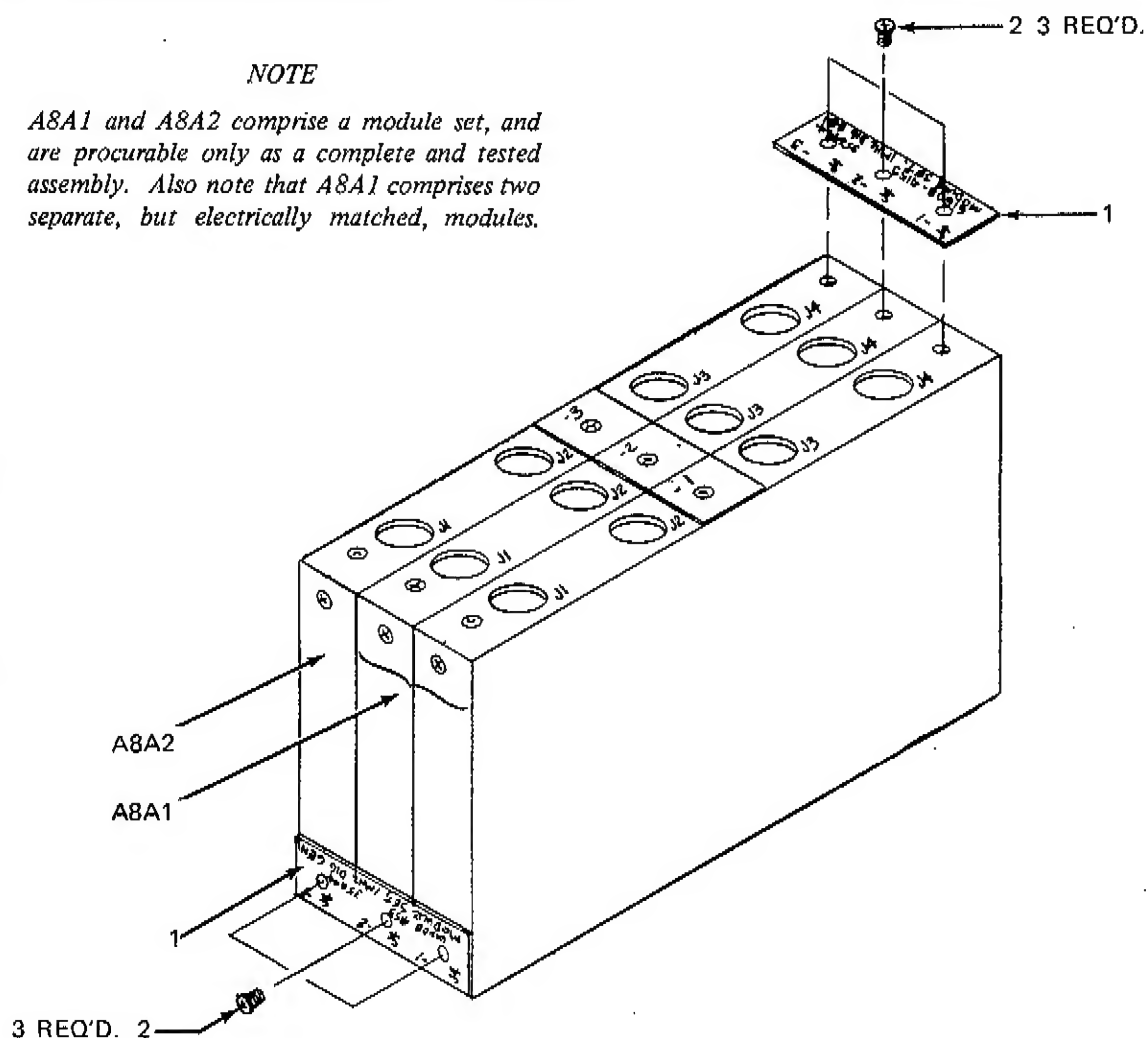


Figure 5-16. 1 MHz DIGIT GENERATOR MODULE SET ASSEMBLY, A8

1 MHz MATCHED MODULE PAIR ASSEMBLY, A8A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8A1	1 MHz MATCHED MODULE PAIR ASSEMBLY Figure 5-17 6160B-4153-1, -2				REF		
A8A1A1	1 MHz Step Loop PCB Assembly 6040A-4003				1		
A8A1A2	Main Loop VCO PCB Assembly 6160B-4005				1		
A8A1A1 CR2, A8A1A1 CR3, A8A1A2 CR1 A8A1A2 CR2	Diode, Pair matched set (not illustrated)	347534	89536	347534	2		
	<i>NOTE!</i> <i>When replacing A8A1A1 or A8A1A2 pcb's, two diode pair sets will have to be ordered separately. One diode from each set will have to be installed in the A8A1A1 pcb and the re- maining diode of each set will be installed in the A8A1A2 pcb.</i>						
1	Cover, inner	323204	89536	323204	2		
2	Cover, outer	323212	89536	323212	2		
3	Screw, 4 - 40 x 1/4 PNH Phillips	129890	73734	19022	10		
4	Nameplate, -1 Assembly	367144	89536	367144	1		
5	Nameplate, -2 Assembly	356378	89536	356378	1		

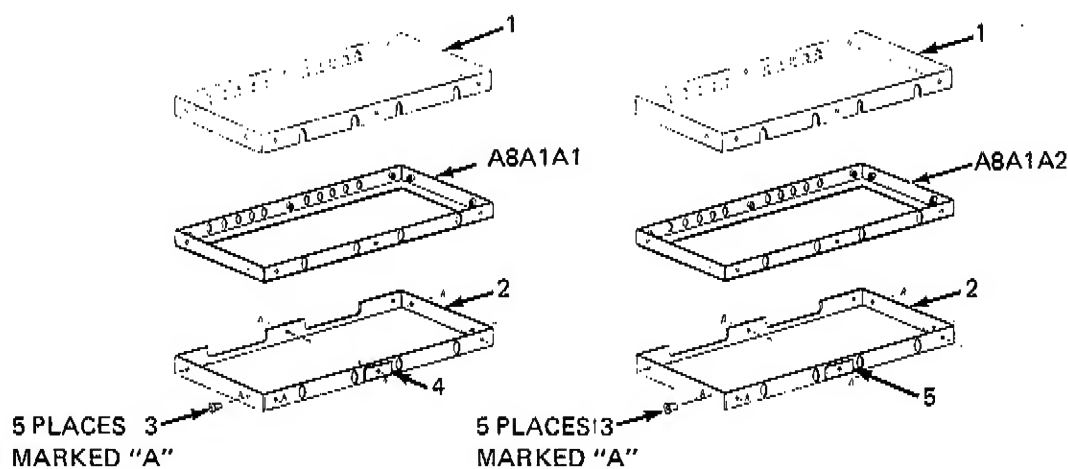


Figure 5-17. 1 MHz MATCHED MODULE PAIR ASSEMBLY, A8A1

1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8A1A1	1 MHz STEP LOOP PCB ASSEMBLY Figure 5-18 6040A-4003				REF		
C1,C2	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	14		
C3	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	6		
C4,C5	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C6	Cap, mica, 560 pf, $\pm 5\%$, 500V	170431	53021	D19F561J	1		
C7	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C8	Cap, mica 4 pf, $\pm 5\%$, 500V	190397	53021	D15C040K	2		
C9,C10	Cap, cer, 0.0012uf, $\pm 10\%$, 500V	106732	71590	CF-122	REF		
C11	Cap, mica, 18pf, $\pm 5\%$, 500V	266585	53021	D15C180J	1		
C12	Cap, tant, 2.2 uf $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C13	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	REF		
C14	Cap, mica, 33 pf, $\pm 10\%$, 500V	160317	53021	D15E330J	1		
C15	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	REF		
C16	Cap, mica, 270pf, $\pm 5\%$, 500V	148452	53021	D15F271J	1		
C17,C18	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C19	Cap, var cer, 4.5 to 50 pf, $+70/-20\%$, 250V	321117	73899	DVJ305A	1		
C20	Cap, mica, 1110 pf, $\pm 1\%$, 500V	170415	53021	D15F111F	1		
C21	Cap, mica, 330 pf, $\pm 5\%$, 500V	148445	53021	D15F331J	1		
C22	Cap, var cer, 1.7 to 10 pf, $+70/-20\%$, 250V	321109	73899	DVJ302A	1		
C23	Cap, mica, 47 pf, $\pm 5\%$, 500V	148536	53021	D15E470J	1		
C24,C26	Cap, mica, 390 pf, $\pm 5\%$, 500V	148437	53021	D15E391J	2		
C25,C27	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C28	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	REF		
C29	Cap, fxd, plstc, diel 0.22 uf, $\pm 10\%$, 50V	271577	06001	75F1R5A222	1		
C30, C32 thru C34	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C31,C36	Cap, cer, 0.05uf, $+80/-20\%$, 25V	148924	72982	5855-Y5U-503Z	2		

1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C35	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101 F103M	1		
C37	Cap, mica, 4 pf, $\pm 5\%$, 500V	190397	53021	D15C040K	REF		
C38 thru C46	Cap, feed-thru	248286	00656	BSF-1BB	9		
CR2, CR3	Diode pair, matched set <i>NOTE!</i> <i>Varactor tuning diodes CR2 and CR3 are matched to CR1 and CR2 in the 1 MHz Main Loop VCO PCB Assembly, A8A1A2. If replacement is required, two matched sets must be ordered. When replacing these diodes, install one diode from each set in the A8A1A1 pcb assembly. Install the remaining diodes of each set in the A8A1A2 pcb assembly.</i>	347534	89536	347534	REF		
CR4	Diode, si, 150mA	203323	03508	1N4148	1	1	
J1 thru J4	Conn, male, coax.	207639	13511	27-875	4		
L1	Choke, 6 turn	320911	89536	320911	11		
L2	Inductor, Type 10K	339234	89536	339234	1		
L3	Choke, RF, 270 uh $\pm 5\%$, 260 mA	186270	72259	WEE-270	1		
L4, L5	Choke, 6 turn	320911	89536	320911	REF		
L6	Choke, RF, 180 uh, $\pm 5\%$, 300 mA	174771	72259	WEE-180	1		
L7	Choke, 6 turn	320911	89536	320911	REF		
L8	Choke, RF, 120 uh, $\pm 10\%$, 330 mA	321042	72259	WEE-120	1		
L9 thru L14, L16	Choke, 6 turn	320911	89536	320911	REF		
Q2 thru Q5	Xstr, si, NPN	248351	04713	MPS918	4	1	

1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q6, Q8, Q10, Q11	Xstr, si, PNP	229898	04713	MPS6522	4	1	
Q7, Q9	Xstr., si, NPN	281081	04713	MPS6520	2	1	
R2	Res, comp, 680 Ω , $\pm 5\%$, $\frac{1}{4}W$	148007	01121	CB6805	2		
R3, R4	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	5		
R5	Res, comp, 200 Ω , $\pm 5\%$, $\frac{1}{4}W$	193482	01121	CB2015	1		
R6	Res, comp, 470 Ω , $\pm 5\%$, $\frac{1}{4}W$	147983	01121	CB4715	1		
R8	Res, comp, 1K, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	5		
R9 thru R11	Res, comp, 120 Ω , $\pm 5\%$, $\frac{1}{4}W$	170712	01121	CB1215	3		
R12	Res, comp, 1.5K, $\pm 5\%$, $\frac{1}{4}W$	148031	01121	CB1525	2		
R13	Res, comp, 1K, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	REF		
R14	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R15	Res, comp, 1.5K, $\pm 5\%$, $\frac{1}{4}W$	148031	01121	CB1525	REF		
R16	Res, comp, 1K, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	REF		
R17	Res, comp, 4.7K, $\pm 5\%$, $\frac{1}{4}W$	148072	01121	CB4725	2		
R18	Res, comp, 8.2K, $\pm 5\%$, $\frac{1}{4}W$	160796	01121	CB8225	3		
R19	Res, comp, 1.2K, $\pm 5\%$, $\frac{1}{4}W$	190371	01121	CB1225	1		
R20	Res, met flm, 649 Ω , $\pm 1\%$, $\frac{1}{8}W$	309955	91637	MFF1-86490F	1		
R21	Res, comp, 4.7K, $\pm 5\%$, $\frac{1}{4}W$	148072	01121	CB4725	REF		
R22	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R23, R24	Res, comp, 1K, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	REF		
R25	Res, comp, 270 Ω , $\pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	1		
R26	Res, comp, 330 Ω , $\pm 5\%$, $\frac{1}{4}W$	147967	01121	CB3315	1		
R27, R28	Res, comp, 8.2K, $\pm 5\%$, $\frac{1}{4}W$	160796	01121	CB8225	REF		
R29	Res, comp, 1.8K, $\pm 5\%$, $\frac{1}{4}W$	175042	01121	CB1825	1		
R30	Res, comp, 3.3K, $\pm 5\%$, $\frac{1}{4}W$	148056	01121	CB3325	1		
R31	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R32	Res, comp 220 Ω , $\pm 5\%$, $\frac{1}{2}W$	186031	01121	EB2215	1		

1 MHz STEP LOOP PCB ASSEMBLY

61608

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R33	Res, comp, 680 Ω , $\pm 5\%$, $\frac{1}{4}W$	148007	01121	CB6805	REF		
R34	Res, comp, 47 Ω , $\pm 5\%$, $\frac{1}{4}W$	147892	01121	CB4705	1		
R35	Res, comp, 39 Ω $\pm 5\%$, $\frac{1}{4}W$	193391	01121	CB3905	1		
U1	IC, TTL, triple 3-input pos AND gate, active pull-up.	363457	01295	SN74S11N	2	1	
U2	IC, TTL, Quad 2-input +NAND gates	293068	01295	SN74H00P	2	1	
U3	IC, Operational amplifier	271502	07263	LM301A	1	1	
U4	IC, TTL, 35MHz, pre-set decade/binary ctr.	320747	01295	SN74176N	1	1	
U5	IC, TTL, phase-frequency detector	320721	04713	MC4044P	1	1	
U6	IC, TTL, dual J-K edge trig, flip-flop.	363440	01295	SN 74S112N	1	1	
U7	IC, TTL, triple 3-input pos. AND gate, w/active pull-up.	363457	01295	SN74S11N	REF		
U8	IC, TTL SSI, dual J-K neg. edge trig flip-flop w/preset & clear.	293100	01295	SN74H106N	1	1	
U9	IC, TTL, 50 MHz, Decade counter	320754	01295	SN74196N	1	1	
U10	IC, TTL, Quad 1-input +NAND gates	293068	01295	SN74H00P	REF		
U11	IC, DTL SSI Hex Inverter	268367	04713	MC836P	1		

1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

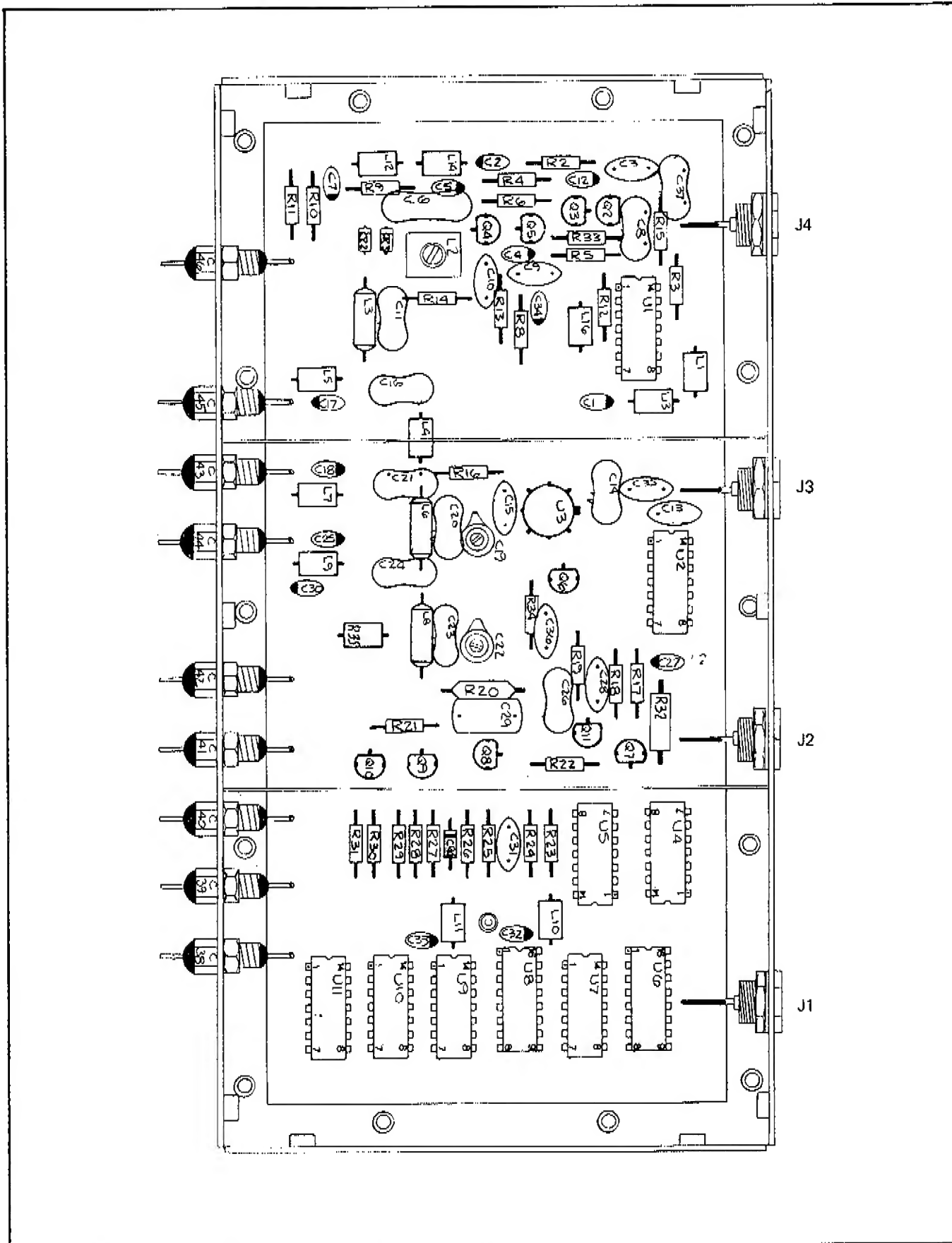


Figure 5-18. 1 MHz STEP LOOP PCB ASSEMBLY, A8A1A1

1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8A1A2	1 MHz MAIN LOOP VCO PCB ASSEMBLY Figure 5-19 6160B-4005				REF		
C1	Cap, mica, 150 pf, $\pm 5\%$, 500V	148478	53021	D15F151J	3		
C2,C3	Cap, mica, 220 pf, $\pm 5\%$, 500V	170423	53021	D15F221J	4		
C4	Cap, tant, 2.2uf, $\pm 20\%$, 20V	161927	56289	96D225X0020	9		
C5,C6, C7	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	7		
C8	Cap, mica, 150 pf, $\pm 5\%$, 500V	148478	53021	D15F151J	REF		
C9, C37	Cap, cer, 0.01 uf, $\pm 20\%$, 100V	149153	56289	C023B101 F103M	2		
C10	Cap, mica, 110 pf, $\pm 1\%$, 500V	170415	53021	D15F111F	1		
C11	Cap, mica, 5 pf, $\pm 10\%$, 500V	148577	53021	D15C050K	1		
C12	Cap, cer, 0.024 uf, $\pm 20\%$, 100V	168435	56289	C023B101H 253M	1		
C13	Cap, mica, 150 pf, $\pm 5\%$, 500V	148178	53021	D15F151J	REF		
C14	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	REF		
C15	Cap, mica, 62 pf, $\pm 5\%$, 500V	276469	53021	D15F620J	1		
C17	Cap, mica, 51 pf, $\pm 5\%$, 500V	277210	53021	D15E5101J	1		
C18, C19	Cap, mica, 220 pf, $\pm 5\%$, 500V	170423	53021	D15F221J	REF		
C21	Cap, mica, 30 pf, $\pm 5\%$, 500V	340570	53021	D155E300JP	1		
C22	Cap, mica, 560 pf, $\pm 5\%$, 500V	170431	53021	D19F561J	1		
C23	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106731	71590	CF-122	REF		
C24 thru C27	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	96D225X0020	REF		
C29	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	REF		
C30	Cap, mica, 4 pf, $\pm 5\%$, 500V	190397	53021	D15C040K	1		
C32	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C33	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	REF		
C34, C35, C36	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		

1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C38,C39 C40,C41	Cap, feed-thru, 2500 pf	248286	00656	BSF-1BB	4		
CR1, CR2	Diode pair, matched set	347534	89536	347534	REF		
	<p><i>NOTE!</i></p> <p><i>Varactor tuning diodes CR1 and CR2 are matched to CR2 and CR3 in the 1 MHz Step Loop PCB Assembly, A8A1A1. If replacement is required, two matched sets must be ordered. When replacing these diodes, install one diode from each set in the A8A1A2 pcb assembly. Install the remaining diodes of each set in the A8A1A1 pcb assembly.</i></p>						
L1, L3	Choke, RF, 0.33 uh, $\pm 20\%$, 1900mA	207605	72259	WEE - .33	2		
L2	Choke, RF, 0.27 uh, $\pm 20\%$, 2000 mA	321018	72259	WEE - .27	1		
L4	Choke, RF, 22 uh, $\pm 20\%$, 590mA	147843	72259	WEE - 22	1		
L5	Choke, RF, 120 uh, $\pm 10\%$, 330mA	321042	72259	WEE 120	1		
L6	Choke, 6 turn	320911	89536	320911	7		
L8	Inductor, Type 10K, .7-1.3 uh at 7.9 MHz	339234	89536	339234	1		
L9,L10, L11,L13, L14,L15	Choke, 6 turn	320911	89536	320911	REF		
J1 thru J4	Conn, male, coax	207639	13511	27-875	4		
Q1 thru Q4	Xstr, si, NPN	248351	04713	MPS918	4	1	
R1	Res, comp, 820Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	3		
R2,R3	Res, comp, 56Ω , $\pm 5\%$, $\frac{1}{4}W$	147900	01121	CB5605	2		
R4,R20	Res, comp, 180Ω , $\pm 5\%$, $\frac{1}{4}W$	147942	01121	CB1815	2		
R5	Res, comp, 100Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	1		
R6,R7	Res, comp, $1K$, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	REF		
R8	Res, comp, 470Ω , $\pm 5\%$, $\frac{1}{4}W$	147983	01121	CB4715	1		
R9	Res, comp, 100Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R10	Res, comp, 120Ω , $\pm 5\%$, $\frac{1}{4}W$	170712	01121	CB1215	1		
R11	Res, comp, 200Ω , $\pm 5\%$, $\frac{1}{4}W$	193482	01121	CB2015	1		

1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R12	Res, comp, 2K, $\pm 5\%$, $\frac{1}{4}W$	202879	01121	CB2025	1		
R13	Res, comp, 1K, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	REF		
R14, R15	Res, comp, 1.5K, $\pm 5\%$, $\frac{1}{4}W$	148031	01121	CB1525	2		
R16	Res, comp, 150 Ω , $\pm 5\%$, $\frac{1}{4}W$	147934	01121	CB1515	1		
R17	Res, comp, 47 Ω , $\pm 5\%$, $\frac{1}{4}W$	147892	01121	CB4705	1		
R18	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	REF		
R19	Res, comp, 270 Ω , $\pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	1		
R21	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	REF		
R22	Res, comp, 27 Ω , $\pm 5\%$, $\frac{1}{4}W$	160812	01121	CB2705	1		
U1	IC, Linear 4 quadrant multi, dbl-bal. mixer	363762	01295	SN76514N	1	1	
U2	IC, TTL, triple 3-input pos. AND gate	363457	01295	SN74S11N	1	1	
U3	IC, MECL 70 MHz, AC coupled, J-K flip-flop	226340	04713	MC1013P	1	1	

1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

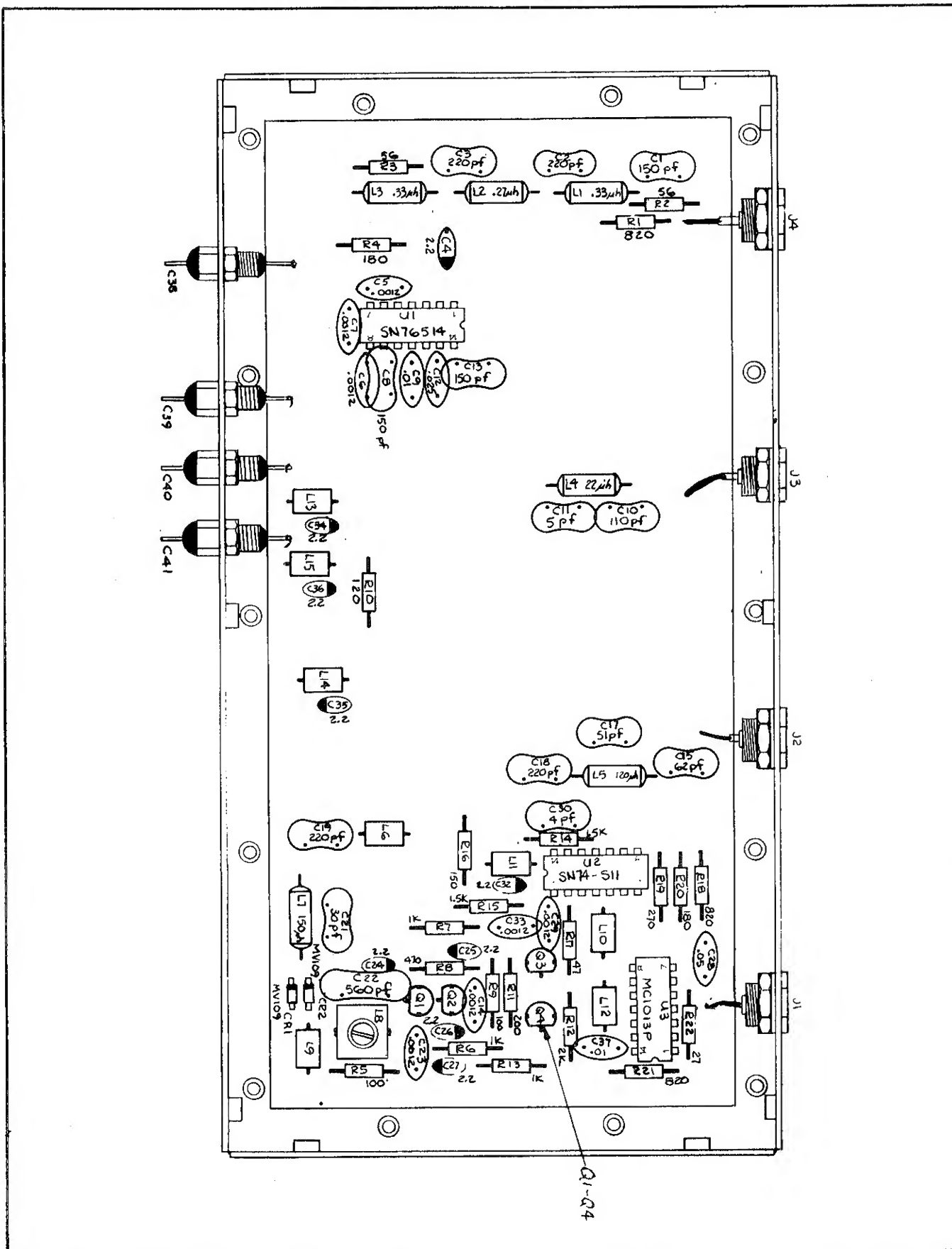


Figure 5-19. 1 MHz MAIN LOOP VCO PCB ASSEMBLY, A8A1A2

1 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY, A8A2

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8A2	1 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY Figure 5-20 6160B-4153-3				REF		
A8A2A1	Main Loop Phase Detector PCB Assembly 6040A-4004				1		
1	Cover, inner	323204	89536	323204	1		
2	Cover, outer	323212	89536	323212	1		
3	Screw, 4 - 40 x 1/4 PNH Phillips	129890	73234	19022	5		
4	Nameplate, -3 Assembly	367169	89536	367169	1		

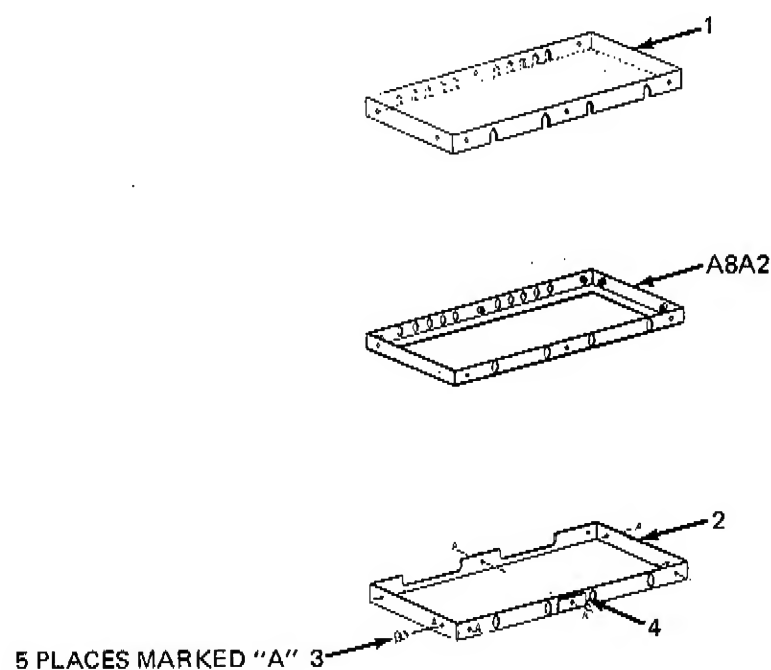


Figure 5-20. 1 MHz MAIN LOOP PHASE DETECTOR MODULE ASSEMBLY, A8A2

1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8A2A1	1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY Figure 5-21 6040A-4004	364919	89536	364919	REF		
C1,C2, C3	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	8		
C4	Cap, Fxd, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F 103M	4		
C5	Cap, mica, 33 pf, $\pm 5\%$, 500V	160317	53021	D15E330J	1		
C6,C7	Cap, Fxd, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F 103M	REF		
C8	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C9	Cap, fxd, cer, 0.025 uf, $\pm 20\%$, 100V	168435	56289	C023D101M 253M	3		
C10	Cap, Fxd plstc, diel, 0.22 uf, $\pm 10\%$, 50V	271577	06001	75FIR5A222	1		
C11	Cap, mica, 22 pf, $\pm 5\%$, 500V	148551	53021	D15E220J	1		
C12	Cap, mica, 51 pf, $\pm 5\%$, 500V	277210	53021	D15E510J	1		
C13	Cap, mica, 120 pf, $\pm 5\%$, 500V	148486	53021	D15F121J	1		
C14	Cap, mica, 62 pf, $\pm 5\%$, 500V	276469	53021	D15F620J	1		
C15, C16	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C17	Cap, fxd cer, 680 pf, $\pm 10\%$, 2000V	207530	72982	801X5F681K	1		
C18	Cap, mica, 110pf, $\pm 1\%$, 500V	170415	53021	D15F111F	1		
C19	Cap, mica, 2 pf, $\pm 5\%$, 500V	175208	53021	D15E020J	1		
C20	Cap, mica, 150 pf, $\pm 5\%$, 500V	148478	53021	D15F151J	1		
C21	Cap, fxd, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F 103M	4		
C22, C23	Cap, fxd, cer, 0.025 uf, $\pm 20\%$, 100V	168435	56289	C023D101M 253M	REF		
C24, C25	Cap, tant, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	8		
C26, C27, C28	Cap, feed-thru	248286	00656	BSF-1BB	3		

1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR1, CR2, CR3	Diode, si, 150mA	203323	03508	1N4148	3	1	
J1 thru J4	Conn, male, coax.	207639	13511	27-875	4		
L1 thru L5	Choke, 6-turn	320911	89536	320911	9		
L6	Inductor	363143	89536	363143	1		
L7	Choke, 6-turn	320911	89536	320911	REF		
L8	Choke, RF	147843	72259	WEE-22	1		
L9 thru L11	Choke, 6-turn	320911	89536	320911	REF		
Q1	Xstr, si, PNP, dual	242016	04713	QD401-78E	1	1	
Q2	Xstr, si, NPN	281081	04783	MPS6520	3	1	
Q3, Q4	Xstr, si, PNP	229898	04713	MPS6522	2	1	
Q5, Q6	Xstr, si, NPN	218081	04713	MPS6520	REF		
R1,R2	Res, comp, 3.3K, $\pm 5\%$, $\frac{1}{4}W$	148056	01121	CB3325	2		
R3	Res, comp, 11K, $\pm 5\%$, $\frac{1}{4}W$	221580	01121	CB1135	1		
R4	Res, comp, 1K, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	4		
R5	Res, var, Cermet, 5K, $\pm 20\%$, 200V	226076	80294	3329H1502	1		
R6	Res, comp, 2.2K, $\pm 5\%$, $\frac{1}{4}W$	148049	01121	CB2225	2		
R7	Res, comp, 47 Ω , $\pm 5\%$, $\frac{1}{4}W$	147892	01121	CB4705	1		
R8, R9	Res, comp, 12K, $\pm 5\%$, $\frac{1}{4}W$	159731	01121	CB1235	2		
R10	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	2		

1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R11	Res, comp, 3.9K, $\pm 5\%$, $\frac{1}{4}W$	148064	01121	CB3925	1		
R12	Res, comp, 4.7K, $\pm 5\%$, $\frac{1}{4}W$	148072	01121	CB4725	2		
R13	Res, comp, 8.2K, $\pm 5\%$, $\frac{1}{4}W$	160796	01121	CB8225	2		
R14	Res, comp, 620 Ω , $\pm 5\%$, $\frac{1}{4}W$	221903	01121	CB6215	1		
R15	Res, comp, 2.2K, $\pm 5\%$, $\frac{1}{4}W$	148049	01121	CB2225	REF		
R16, R17	Res, comp, 1K, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	REF		
R18	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	1		
R19	Res, comp, 1K, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	REF		
R20	Res, comp, 47K, $\pm 5\%$, $\frac{1}{4}W$	148163	01121	CB4735	1		
R21	Res, comp, 4.7K, $\pm 5\%$, $\frac{1}{4}W$	148072	01121	CB4725	REF		
R22	Res, comp, 8.2K, $\pm 5\%$, $\frac{1}{4}W$	160796	01121	CB8225	REF		
R23	Res, comp, 51 Ω , $\pm 5\%$, $\frac{1}{4}W$	221879	01121	CB5105	1		
R24	Res, comp, 1.5K, $\pm 5\%$, $\frac{1}{4}W$	148031	01121	CB1525	3		
R25, R26	Res, comp, 10K, $\pm 5\%$, $\frac{1}{4}W$	148106	01121	CB1035	2		
R27	Res, comp, 15 Ω , $\pm 5\%$, $\frac{1}{4}W$	147876	01121	CB1505	1		
R28	Res, comp 430 Ω , $\pm 5\%$, $\frac{1}{4}W$	203869	01121	CB4315	1		
R29, R30	Res, comp, 1.5K, $\pm 5\%$, $\frac{1}{4}W$	148031	01121	CB1525	REF		
R31	Res, comp 27 Ω , $\pm 5\%$, $\frac{1}{4}W$	160812	01121	CB2705	1		
R32	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
U1	IC, operational amplifier	271502	07263	LM301A	1	1	
U2	IC, TTL, 50 MHz, decade counter	320754	01295	SN74196N	1	1	
U3	IC, TTL, phase frequency detector	320721	04713	MC4044P	1	1	
U4	IC, TTL, quad 2-input +NAND gates	293068	01295	SN74H00P	1	1	

1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

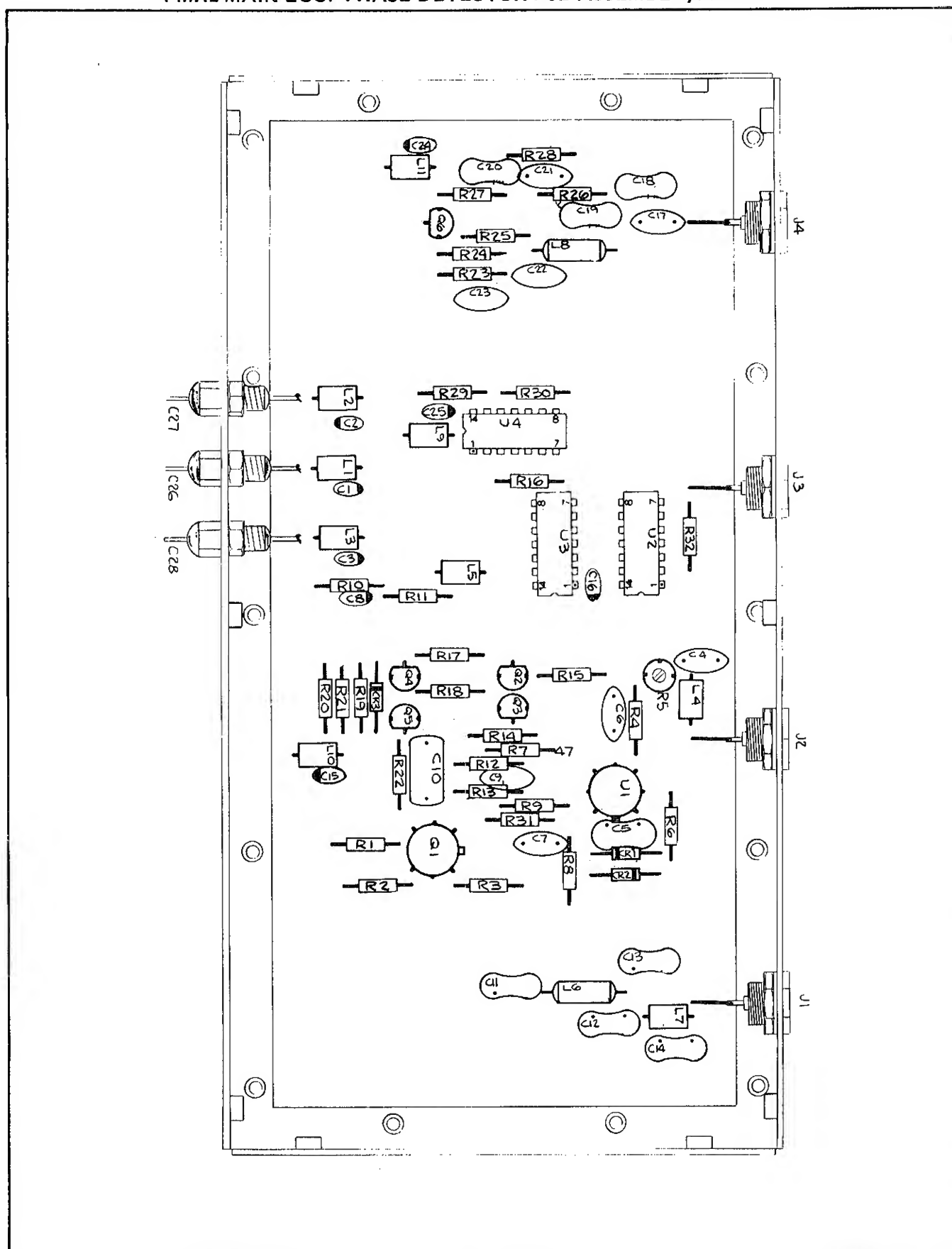


Figure 5-21. 1 MHz MAIN LOOP PHASE DETECTOR PCB ASSEMBLY, A8A2A1

SIX DIGIT GENERATOR MODULE ASSEMBLY, A9

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A9	SIX DIGIT GENERATOR MODULE ASSEMBLY Figure 5-22 6040A - 4102	367094	89536	367094	REF		
A9A1	Six Digit Generator PCB Assembly				1		
1	Cover, inner	365031	89536	365031	1		
2	Cover, outer	365049	89536	365049	1		
3	Screw, 4 - 40 x 1/4, PNH - Phillips	129890	73734	19022	5		
4	Nameplate	367136	89536	367136	1		

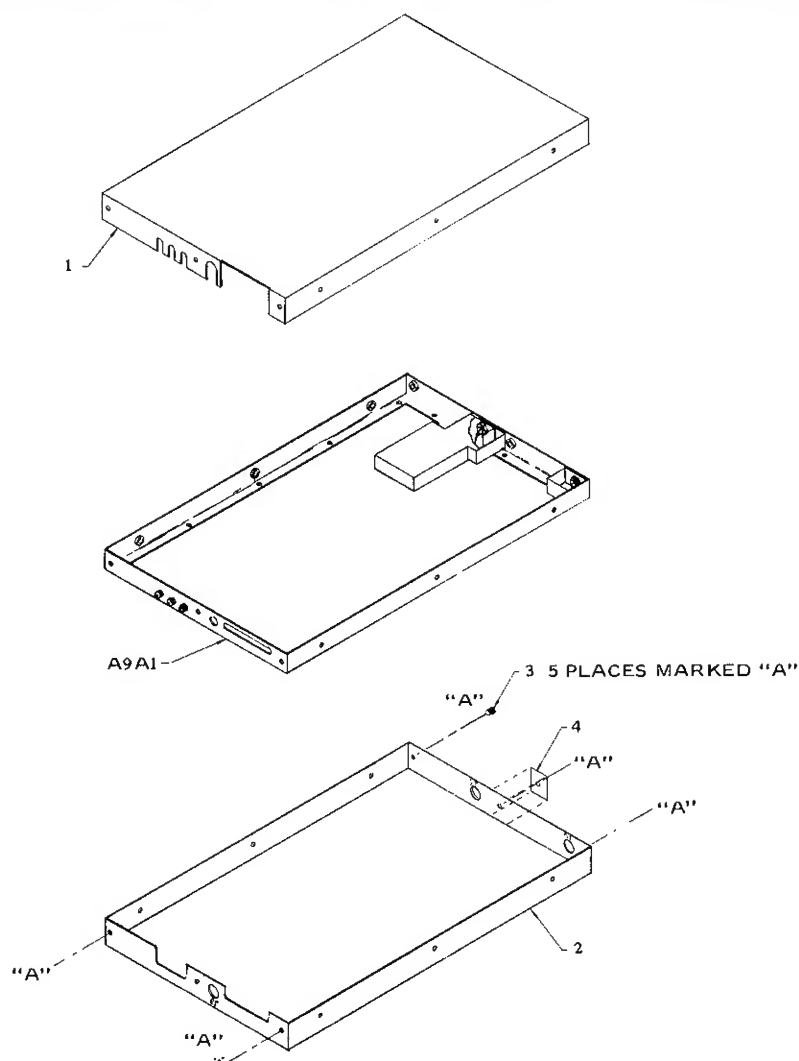


Figure 5-22. SIX DIGIT GENERATOR MODULE ASSEMBLY, A9

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A9A1	SIX DIGIT, GENERATOR PCB ASSY. Figure 5-23 6040A-4002				REF		
C1	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	28		
C2	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	18		
C4	Cap, cer, 0.01uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C5	Cap, mica, 1000 pf, $\pm 5\%$, 500V	148387	53021	D19FD102J03	3		
C6	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C7	Cap, mica, 360 pf, $\pm 5\%$, 500V	325878	53021	D15FD361J03	1		
C8	Cap, mica, 1200 pf, $\pm 5\%$, 500V	148379	53021	D19FD122J03	2		
C9	Cap, mica, 390 pf, $\pm 5\%$, 500V	148437	53021	D15FD391J03	3		
C10	Cap, mica, 1200 pf, $\pm 5\%$, 500V	148379	53021	D19FD122J03	REF		
C11	Cap, mica, 18 pf, $\pm 5\%$, 500V	266585	53021	D15CD180J03	1		
C12	Cap, mica, 390 pf, $\pm 5\%$, 500V	148437	53021	D15FD391J03	REF		
C13	Cap, cer, 300 pf, $\pm 10\%$, 500V	105734	71590	BB60301KW7W	1		
C14	Cap, mica, 33 pf, $\pm 5\%$, 500V	160317	53021	D15ED330J03	3		
C15, C16	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	24		
C17	Cap, plstc, 0.033 uf, $\pm 10\%$, 250V	234492	73445	C280AE/A33K	1		
C18	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C19	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C20, C21, C22, C23, C24	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C25	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C26	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C27	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C28	Cap, mica, 1300 pf, $\pm 5\%$, 500V	182881	53021	D19FD1300J03	2		
C29	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C30	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F10M	REF		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C31	Cap, mica, 1000 pf, $\pm 5\%$, 500V	148387	53021	D19F102J	REF		
C32, C33	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C34	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C35	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C36	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	2		
C37, C38	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C39	Cap, mica, 82 pf, $\pm 5\%$, 500V	148502	53021	D15ED820J03	2		
C40, C41	Cap, mica, 150 pf, $\pm 5\%$, 500V	148478	53021	D15FD151J03	2		
C42	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B10F103M	REF		
C43	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C44	Cap, mica, 1000 pf, $\pm 5\%$, 500V	148387	53021	CD19FD102J03	REF		
C45	Cap, mica, 33 pf, $\pm 5\%$, 500V	160317	53021	CD15ED330J03	REF		
C46, C47	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C48	Cap, plstc, 0.027 uf, $\pm 10\%$, 250V	267120	73445	C280AE/A27K	3		
C49	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C50	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C51	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C52	Cap, mica, 82 pf, $\pm 5\%$, 500V	148502	53021	D15ED820J03	REF		
C53, C54, C55, C56, C57, C58	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C59	Cap, mica, 91 pf, $\pm 5\%$, 500V	277228	53021	D15FD91J03	2		
C60	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C61	Cap, mica, 91 pf, $\pm 5\%$, 500V	277228	53021	D15FD91J03	REF		
C62	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C63	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C64	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C65	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023101F103M	REF		
C66	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C67	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C68	Cap, mica, 1500 pf, $\pm 5\%$, 500V	148361	53021	D19FD152J03	4		
C69	Cap, mica, 200 pf, $\pm 5\%$, 500V	272880	53021	D15FD201J03	2		
C70	Cap, mica, 390 pf, $\pm 5\%$, 500V	148437	53021	D15FD391J03	REF		
C71	Cap, plstc, 0.015 uf, $\pm 10\%$, 200V	182154	14655	DMF2515	1		
C72	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C73	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C74	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C75	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		
C76	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C77	Cap, mica, 1500 pf, $\pm 5\%$, 500V	148361	53021	D19FD152J03	REF		
C78	Cap, mica, 270 pf, $\pm 5\%$, 500V	148452	53021	D15FD271J03	2		
C79	Cap, mica, 1500 pf, $\pm 5\%$, 500V	148361	53021	D19FD152J03	REF		
C80	Cap, mica, 200 pf, $\pm 5\%$, 500V	272880	53021	D15FD201J03	REF		
C81	Cap, mica, 430 pf, $\pm 5\%$, 500V	177980	14655	D15FD431J03	1		
C82	Cap, cer, 0.0012 uf, $\pm 10\%$, 500V	106732	71590	CF-122	REF		
C83	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C84	Cap, mica, 33 pf, $\pm 5\%$, 500V	160317	53021	D15ED330J03	REF		
C85	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C86	Cap, ta, 68 uf, $\pm 20\%$, 15V	193615	56289	196D68X0015-LA3	3		
C87 thru C91	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C93	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C94	Cap, ta, 2.2 uf, $\pm 20\%$, 20V	161927	56289	196D225X0020	REF		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C95 thru C98	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C99, C100	Cap, ta, 68 uf, $\pm 20\%$, 15V	193615	56289	196D686X0015 L A3	REF		
C101, C102	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C103	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C104	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C105	Cap, mica, 1500 pf, $\pm 5\%$, 500V	148361	53021	D19FD152J03	REF		
C106	Cap, mica, 480 pf, $\pm 1\%$, 500V	182931	53021	D19ED481F03	1		
C107	Cap, mica, 1300 pf, $\pm 5\%$, 500V	182881	53021	D19FD132J03	REF		
C108	Cap, mica, 270 pf, $\pm 5\%$, 500V	148452	53021	D15FD221J03	REF		
C109	Cap, mica, 220 pf, $\pm 5\%$, 500V	170423	53021	D15FD271J03	1		
C110	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C111, C112	Cap, plstc, 0.02 uf, $\pm 10\%$, 250V	267120	73445	C280AE/A27K	REF		
C113	Cap, ta, 10 uf, $\pm 20\%$, 20V	330662	12954	D10GSB20M	REF		
C114, C115	Cap, cer, 0.01 uf, $\pm 20\%$, 50V	149153	56289	C023B101F103M	REF		
C116, C117, C118	Cap, feed-thru	248286	04222	BSF-1BB	3		
CR1, CR2	Diode, tuning, matched set	347534	89536	347534	1		
CR3, CR4, CR5, CR6	Diode, si, 150 mA	203323	03508	1N4148	5	2	
CR7, CR10	Diode, tuning, matched set	347534	89536	347534	1	1	
CR8	Diode, germanium, 80 mA, 100 piv	149187	93332	1N270	1	1	
CR9	Diode, si, 150 mA	203323	03508	1N4148	REF		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR12	Diode, tuning, 200 mA	363812	04713	MV109	1	1	
J1, J2, J3	Conn, male, coaxial	207639	13511	27-875	3		
L1, L2	Choke, 6-turn	320911	89536	320911	20		
L3, L4, L5	Inductor, 6800 uh, 62 mA	363184	24759	MR-6800	3		
L6, L7, L8, L9, L10, L11	Choke, 6-turn	320911	89536	320911	REF		
L12	Inductor, 1,000 uh, 140 mA	147819	72259	WEE1000	1		
L13, L14	Choke, rf, 22 uh, $\pm 20\%$, 590 mA	147843	72259	WEE22	3		
L15, L16	Choke, 6-turn	320911	89536	320911	REF		
L17	Inductor, 470 uh, $\pm 5\%$, 180 mA	147827	72259	WEE470	1		
L18, L19	Choke, 6-turn	320911	89536	320911	REF		
L20	Inductor, 39000 uh, 31 mA	363200	24759	MR39000	1		
L21	Inductor, 27000 uh, 34 mA	363192	24759	MR27000	1		
L22, L23, L24, L25, L26	Choke, 6-turn	320911	89536	320911	REF		
L27	Choke, rf, 22 uh, $\pm 20\%$, 590 mA	147843	72259	WEE22	REF		
L28	Inductor, 100,000 uh, 22 mA	363226	24759	MR100,000	1		
L29	Inductor, 82,000 uh, 23 mA	363218	24759	MR82,000	1		
L30, L31, L32	Choke, 6-turn	320911	89536	320911	REF		
Q1, Q2	Xstr, si, PNP	340471	07263	2N4917	4	1	

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q3, Q4, Q5	Xstr, si, NPN	248351	04713	MPS918	17	4	
Q6	Xstr, si, PNP	226290	04713	MPS3640	12	3	
Q7	Xstr, si, PNP	229898	04713	MPS6522	1	1	
Q8	Xstr, si, PNP	226290	04713	MPS3640	REF		
Q9	Xstr, si, NPN	248351	04713	MPS918	REF		
Q10, Q11	Xstr, si, PNP	226290	04713	MPS3640	REF		
Q12, Q13	Xstr, si, NPN	248351	04713	MPS918	REF		
Q14	Xstr, si, NPN	218396	04713	2N3904	5	1	
Q15, Q16	Xstr, si, NPN	248351	04713	MPS918	REF		
Q17	Xstr, si, PNP	226290	04713	MPS3640	REF		
Q18, Q19	Xstr, si, NPN	248351	04713	MPS918	REF		
Q20	Xstr, si, NPN	218396	04713	2N3904	REF		
Q21	Xstr, si, NPN	218396	04713	2N3904	REF		
Q22, Q23	Xstr, si, NPN	248351	04713	MPS918	REF		
Q24, Q25	Xstr, si, NPN	218396	04713	2N3904	REF		
Q26, Q27	Xstr, si, NPN	248351	04713	MPS918	REF		
Q28 thru Q31	Xstr, si, PNP	226290	04713	MPS3640	REF		
Q32, Q33	Xstr, si, PNP	340471	07263	2N4917	REF		
Q34, Q35, Q36	Xstr, si, PNP	226290	04713	MPS3640	REF		
Q37, Q38, Q39	Xstr, si, NPN	248351	04713	MPS918	REF		
R1	Res, comp, 200 Ω , $\pm 5\%$, $\frac{1}{4}W$	193482	01121	CB2015	51		
R3	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	16		
R4	Res, comp, 360 Ω , $\pm 5\%$, $\frac{1}{4}W$	340844	01121	CB3615	5		
R5	Res, comp, 270 Ω , $\pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	5		
R6, R7	Res, comp, 1.2k, $\pm 5\%$, $\frac{1}{4}W$	190371	01121	CB1225	10		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R8	Res, comp, 3k, $\pm 5\%$, $\frac{1}{4}W$	193508	01121	CB3025	5		
R9	Res, comp, 270 Ω , $\pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	REF		
R10, R11	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R12	Res, comp, 47k, $\pm 5\%$, $\frac{1}{4}W$	148163	01121	CB4735	2		
R13	Res, comp, 2.7k, $\pm 5\%$, $\frac{1}{4}W$	170720	01121	CB2725	1		
R14	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147962	01121	CB1015	REF		
R15	Res, comp, 560k, $\pm 5\%$, $\frac{1}{4}W$	220533	01121	CB5645	1		
R16	Res, comp, 4.3k, $\pm 5\%$, $\frac{1}{4}W$	193375	01121	CB4325	2		
R17	Res, comp, 7.5k, $\pm 5\%$, $\frac{1}{4}W$	193326	01121	CB7525	4		
R18	Res, mtl flm, 3.92k, $\pm 1\%$, 1/8W	294801	91637	MFF1-83921F	1		
R19	Res, mtl flm, 3.83k, $\pm 1\%$, 1/8W	235143	91637	MFF1-83831	1		
R20	Res, comp, 62 Ω , $\pm 5\%$, $\frac{1}{4}W$	261842	01121	CB6205	1		
R21	Res, mtl flm, 750 Ω , $\pm 1\%$, $\frac{1}{4}W$	312801	91637	MFF1-87500F	3		
R22	Res, mtl flm, 9.09k $\pm 1\%$, 1/8W	221663	91637	MFF1-89091F	1		
R23	Res, comp, 1.8k, $\pm 5\%$, $\frac{1}{4}W$	175042	01121	CB1825	1		
R24	Res, comp, 560 Ω , $\pm 5\%$, $\frac{1}{4}W$	147991	01121	CB5615	1		
R25	Res, comp, 200 Ω , $\pm 5\%$, $\frac{1}{4}W$	193482	01121	CB2015	REF		
R27	Res, comp, 360 Ω , $\pm 5\%$, $\frac{1}{4}W$	340844	01121	CB3615	REF		
R28	Res, comp, 51 Ω , $\pm 5\%$, $\frac{1}{4}W$	221879	01121	CB5105	1		
R29	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	340844	01121	CB3615	REF		
R30,R31	Res, comp, 1.2k, $\pm 5\%$, $\frac{1}{4}W$	190371	01121	CB1225	REF		
R32	Res, comp, 3k, $\pm 5\%$, $\frac{1}{4}W$	193508	01121	CB3025	REF		
R33	Res, comp, 270 Ω , $\pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	REF		
R34	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R35	Res, comp, 300 Ω , $\pm 5\%$, $\frac{1}{4}W$	348276	01121	CB1015	REF		
R36	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R37,R38	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	5		
R39	Res, comp, 10 Ω , $\pm 5\%$, $\frac{1}{4}W$	147868	01121	CB1005	2		
R40	Res, comp, 1k, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	2		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R41	Res, comp, 6.2k, $\pm 5\%$, $\frac{1}{4}W$	221911	01121	CB6225	4		
R42	Res, comp, 15k, $\pm 5\%$, $\frac{1}{4}W$	148114	01121	CB1535	2		
R43	Res, comp, 22k, $\pm 5\%$, $\frac{1}{4}W$	148130	01121	CB2235	1		
R44	Res, comp, 680 Ω , $\pm 5\%$, $\frac{1}{4}W$	148007	01121	CB6815	1		
R45	Res, comp, 2M, $\pm 5\%$, $\frac{1}{4}W$	268771	01121	CB2055	1		
R46	Res, comp, 30k, $\pm 5\%$, $\frac{1}{4}W$	193417	01121	CB3035	1		
R47	Res, comp, 7.5k, $\pm 5\%$, $\frac{1}{4}W$	193326	01121	CB7525	REF		
R48	Res, comp, 10k, $\pm 5\%$, $\frac{1}{4}W$	148106	01121	CB1035	2		
R49	Res, comp, 9.1k, $\pm 5\%$, $\frac{1}{4}W$	193318	01121	CB9125	1		
R50	Res, comp, 3.9k, $\pm 5\%$, $\frac{1}{4}W$	148064	01121	CB3925	2		
R51	Res, comp, 12k, $\pm 5\%$, $\frac{1}{4}W$	159731	01121	CB1235	1		
R52	Res, comp, 1.3k, $\pm 5\%$, $\frac{1}{4}W$	234252	01121	CB1325	1		
R53	Res, comp, 120k, $\pm 5\%$, $\frac{1}{4}W$	193458	01121	CB1245	1		
R54	Res, comp, 200 Ω , $\pm 5\%$, $\frac{1}{4}W$	193482	01121	CB2015	REF		
R56, R57	Res, comp, 1.2k, $\pm 5\%$, $\frac{1}{4}W$	190371	01121	CB1225	REF		
R58	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R59	Res, comp, 3k, $\pm 5\%$, $\frac{1}{4}W$	193508	01121	CB3025	REF		
R60	Res, comp, 270 Ω , $\pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	REF		
R61	Res, comp, 150 Ω , $\pm 5\%$, $\frac{1}{4}W$	147934	01121	CB1515	1		
R62	Res, comp, 180 Ω , $\pm 5\%$, $\frac{1}{4}W$	147942	01121	CB1815	2		
R63	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R64	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	REF		
R65	Res, comp, 10 Ω , $\pm 5\%$, $\frac{1}{4}W$	147868	01121	CB1005	REF		
R66	Res, comp, 1k, $\pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	REF		
R67	Res, comp, 6.2k, $\pm 5\%$, $\frac{1}{4}W$	221911	01121	CB6225	REF		
R68	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	REF		
R69	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R70	Res, comp, 6.2k, $\pm 5\%$, $\frac{1}{4}W$	221911	01121	CB6225	REF		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R71	Res, comp, 15k, $\pm 5\%$, $\frac{1}{4}W$	148114	01121	CB1535	REF		
R72	Res, comp, 360 Ω , $\pm 5\%$, $\frac{1}{4}W$	340844	01121	CB3615	REF		
R73	Res, comp, 750 Ω , $\pm 5\%$, $\frac{1}{4}W$	218024	01121	CB7515	2		
R74	Res, comp, 13k, $\pm 5\%$, $\frac{1}{4}W$	221598	01121	CB1335	2		
R75	Res, comp, 1M, $\pm 5\%$, $\frac{1}{4}W$	182204	01121	CB1055	1		
R77	Res, comp, 200 Ω , $\pm 5\%$, $\frac{1}{4}W$	193482	01121	CB2015	REF		
R78	Res, comp, 270 Ω , $\pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	REF		
R79	Res, comp, 3k, $\pm 5\%$, $\frac{1}{4}W$	193508	01121	CB3025	REF		
R80, R81	Res, comp, 1.2k, $\pm 5\%$, $\frac{1}{4}W$	190371	01121	CB1225	REF		
R82, R83	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R84	Res, mtl flm, 13k, $\pm 1\%$, $\frac{1}{8}W$	335539	91637	MFF1-81302F	1		
R85	Res, comp, 3.9k, $\pm 5\%$, $\frac{1}{4}W$	148064	01121	CB3925	REF		
R86	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	REF		
R87	Res, mtl flm, 20k, $\pm 5\%$, $\frac{1}{4}W$	221614	01121	CB2035	1		
R88	Res, mtl flm, 27k, $\pm 5\%$, $\frac{1}{4}W$	148148	01121	CB2735	1		
R89	Res, mtl flm, 1.3k, $\pm 1\%$, $\frac{1}{8}W$	343921	91637	MFF1-81301F	1		
R90	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	REF		
R91	Res, comp, 360 Ω , $\pm 5\%$, $\frac{1}{4}W$	340844	01121	CB3615	REF		
R92	Res, mtl flm, 2.67k, $\pm 1\%$, $\frac{1}{8}W$	289587	91637	MFF1-82671	1		
R93	Res, comp, 6.2M, $\pm 5\%$, $\frac{1}{4}W$	221960	01121	CB6255	1		
R94	Res, comp, 6.2k, $\pm 5\%$, $\frac{1}{4}W$	221911	01121	CB6225	REF		
R95	Res, comp, 10k, $\pm 5\%$, $\frac{1}{4}W$	148106	01121	CB1035	REF		
R96	Res, comp, 7.5k, $\pm 5\%$, $\frac{1}{4}W$	193326	01121	CB7525	REF		
R97	Res, comp, 220 Ω , $\pm 5\%$, $\frac{1}{4}W$	147959	01121	CB2215	1		
R98	Res, comp, 180 Ω , $\pm 5\%$, $\frac{1}{4}W$	147942	01121	CB1815	REF		
R99, R100	Res, comp, 1.2k, $\pm 5\%$, $\frac{1}{4}W$	190371	01121	CB1225	REF		
R101	Res, comp, 3k, $\pm 5\%$, $\frac{1}{4}W$	193508	01121	CB3025	REF		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R102, R103	Res, comp, 100Ω, ±5%, ¼W	147926	01121	CB1015	REF		
R104	Res, comp, 2k, ±5%, ¼W	202879	01121	CB2025	1		
R106	Res, comp, 200Ω, ±5%, ¼W	147926	01121	CB2015	REF		
R107	Res, comp, 4.3k, ±5%, ¼W	193375	01121	CB4325	REF		
R108	Res, comp, 4.7k, ±5%, ¼W	148072	01121	CB4725	1		
R109	Res, comp, 2.4 M, ±5%, ¼W	221945	01121	CB2415	1		
R110	Res, comp, 47k, ±5%, ¼W	148163	01121	CB4735	REF		
R111	Res, comp, 1.6k, ±5%, ¼W	266197	01121	CB1625	1		
R112	Res, comp, 100Ω, ±5%, ¼W	147926	01121	CB1015	REF		
R113	Res, comp, 360Ω, ±5%, ¼W	340844	01121	CB3615	REF		
R114	Res, comp, 2.4k, ±5%, ¼W	193433	01121	CB2425	1		
R115	Res, comp, 7.5k, ±5%, ¼W	193326	01121	CB7525	REF		
R116	Res, comp, 750Ω, ±5%, ¼W	218024	01121	CB7515	REF		
T1, T2, T3, T4	Inductor, type 10k, 1.4-1.9 uh @7.9 MHz	345850	89536	345850	4		
T5	Inductor, type 10k, .7-1.3 uh @ 7.9 MHz	339234	89536	339234	1		
U1	IC, TTL, triple 3-input posAND gate	340448	01295	SN74H11N	7	2	
U2	IC, DTL, SSI, hex inverter	268367	04713	MC836P	2	1	
U3	IC, TTL (Schottky)quad 2-input NAND gate	363580	01295	SN74S00N	1	1	
U4	IC, DTL, SSI, hex inverter	268367	04713	MC836P	REF		
U5	IC, TTL, triple 3-input pos AND gate	340448	01295	SN74H11N	REF		
U6	IC, TTL, 50 MHz, decade counter	320754	01295	SN74196N	5	1	
U7	IC, DTL, quad 2-input NAND gate	268375	04713	MC846P	1	1	
U8	IC, TTL, 50 MHz, decade counter	320754	01295	SN74196N	REF		
U9	IC, TTL, JK flip-flop, AND inputs	293092	01295	SN74H102N	4	1	
U10	IC, TTL, SSI, dual J-K neg. edge-trig. flip-flop w/preset and clear	293100	01295	SN74H106N	4	1	
U11	IC, TTL, JK flip-flop, AND inputs	293092	01295	SN74H102N	REF		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

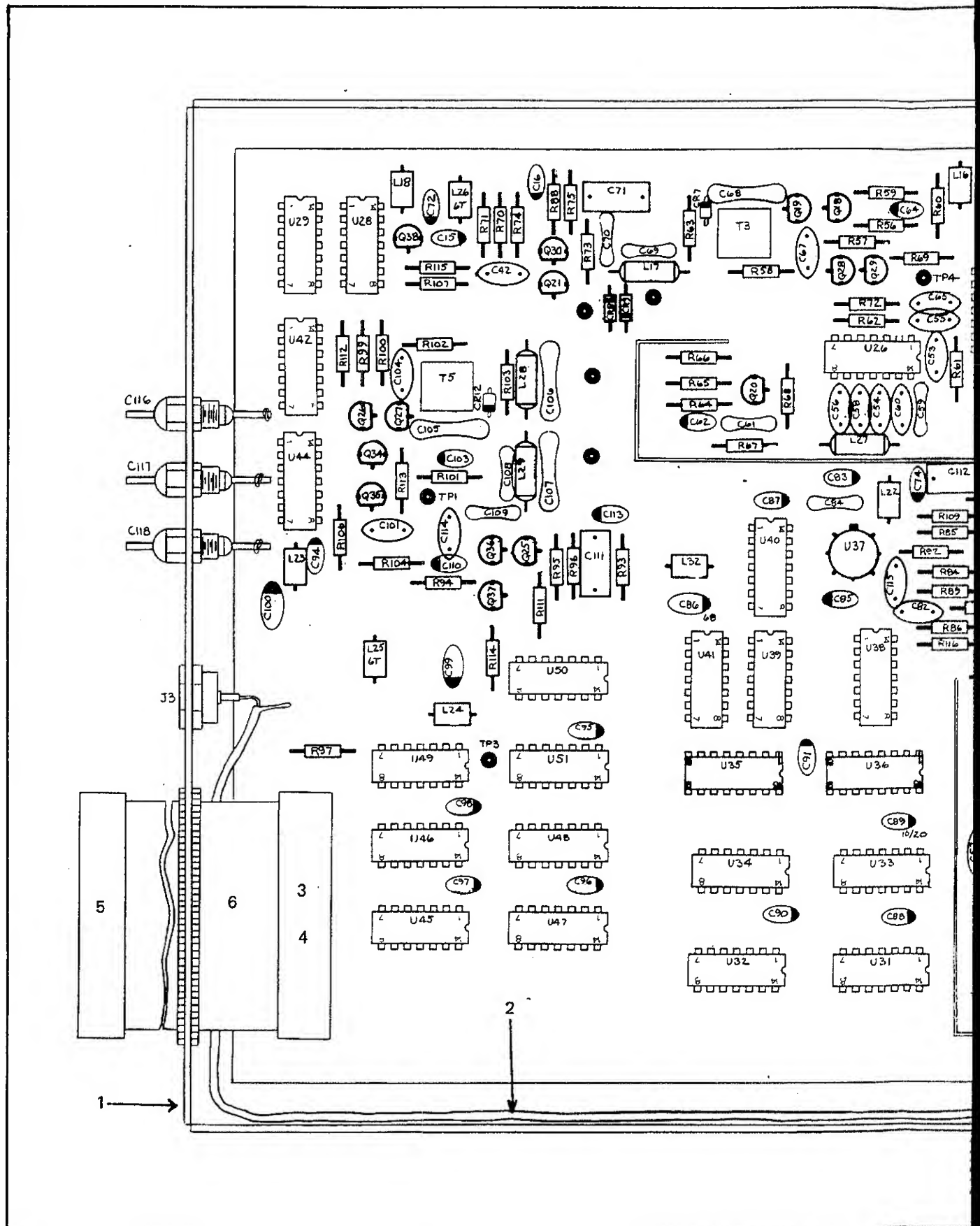
6160B

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U12	IC, TTL, SSI, dual J-K neg. edge-trig. flip-flop w/preset and clear	293100	01295	SN74H106N	REF		
U13	IC, operational amplifier	271502	07263	LM301A	3	1	
U14	IC, TTL, phase-frequency detector	320721	04713	MC4044P	5	1	
U15	IC, TTL, MSI, decade counters	293159	01295	SN7490N	3	1	
U16	IC, TTL, quad-2-input NAND gate	292953	01295	SN7400N	3	1	
U17	IC, TTL, quad 2-input + NAND gates	293068	01295	SN74H00P	2	1	
U18	IC, TTL, triple 3-input pos AND gate	340448	01295	SN74H11N	REF		
U19	IC, linear 4-quadrant multiplier, db mix	363762	01295	SN76514N	2	1	
U21	IC, TTL, phase-frequency detector	320721	04713	MC4044P	REF		
U22	IC, TTL, MSI, decade counters	293159	01295	SN7490N	REF		
U23	IC, operational amplifier	271502	07263	LM301A	REF		
U24	IC, TTL, 50 MHz, decade counter	320754	01295	SN74196N	REF		
U25	IC, TTL, triple 3-input pos AND gate	340448	01295	SN74H11N	REF		
U26	IC, linear 4-quadrant multiplier, db mix	363762	01295	SN76514N	REF		
U28	IC, TTL, phase-frequency detector	320721	04713	MC4044P	REF		
U29	IC, TTL, MSI, decade counters	293159	01295	SN7490N	REF		
U30	IC, TTL, triple 3-input pos AND gate	340448	01295	SN74H11N	REF		
U31	IC, TTL, quad 2-input + NAND gates	293068	01295	SN74H00P	REF		
U32, U45	IC, digital presettable hi-speed decade/ binary counter	348250	18324	N8290A	2	1	
U33	IC, TTL, JK flip-flop, AND inputs	293092	01295	SN74H102N	REF		
U34	IC, TTL, 50 MHz preset decoded binary counter/latch	320770	01295	SN74197N	2	1	
U35, U36	IC, TTL, SSI, dual J-K neg. edge-trig.	293100	01295	SN74H106N	REF		
U37	IC, operational amplifier	271502	07263	LM301A	REF		
U38	IC, TTL, phase-frequency detector	320721	04713	MC4044P	REF		
U39	IC, TTL J-K flip-flop	296491	01295	SN7472N	2	1	
U40, U41	IC, TTL, quad 2-input NAND gate	292953	01295	SN7400N	REF		

SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U42	IC, TTL, 35 MHz presettable decade and binary counter	320747	01295	SN74176N	1	1	
U44	IC, TTL, triple 3-input pos AND gate	340448	01295	SN74H11N	REF		
U46	IC, TTL, 50 MHz, decade counter	320754	01295	SN74196N	REF		
U47	IC, TTL, triple 3-input pos AND gate	340448	01295	SN74H11N	REF		
U48	IC, TTL, J-K, flip-flop, AND inputs	293092	01295	SN74H102N	REF		
U49	IC, TTL, 50 MHz preset decoded binary counter latch	320770	01295	SN74197N	REF		
U50	IC, TTL, phase-frequency detector	320721	04713	MC4044P	REF		
U51	IC, TTL, J-K flip-flop	296491	01295	SN7472N	REF		
2	Cable, rf	190322	89536	190322	24 in.		
3	Conn, body	295337	35037	3402 body	1		
4	Conn, cover	295329	35037	3402 cover	1		
5	Connector, 34 pin	325910	35037	3424	1		
6	Cable, flat	291807	35037	3350	2.17 Ft.		
7	Ferrite tube, choke core	321182	02114	56-590-65-4B	1		
		103424	12014	R3647 x 532	16		
	Socket, IC, 14 contact (not illustrated)	276527	23880	TSA-2900-16W	5		

FIG. 5-23
SHT. 1 OF 3



SHT. 2 OF 3

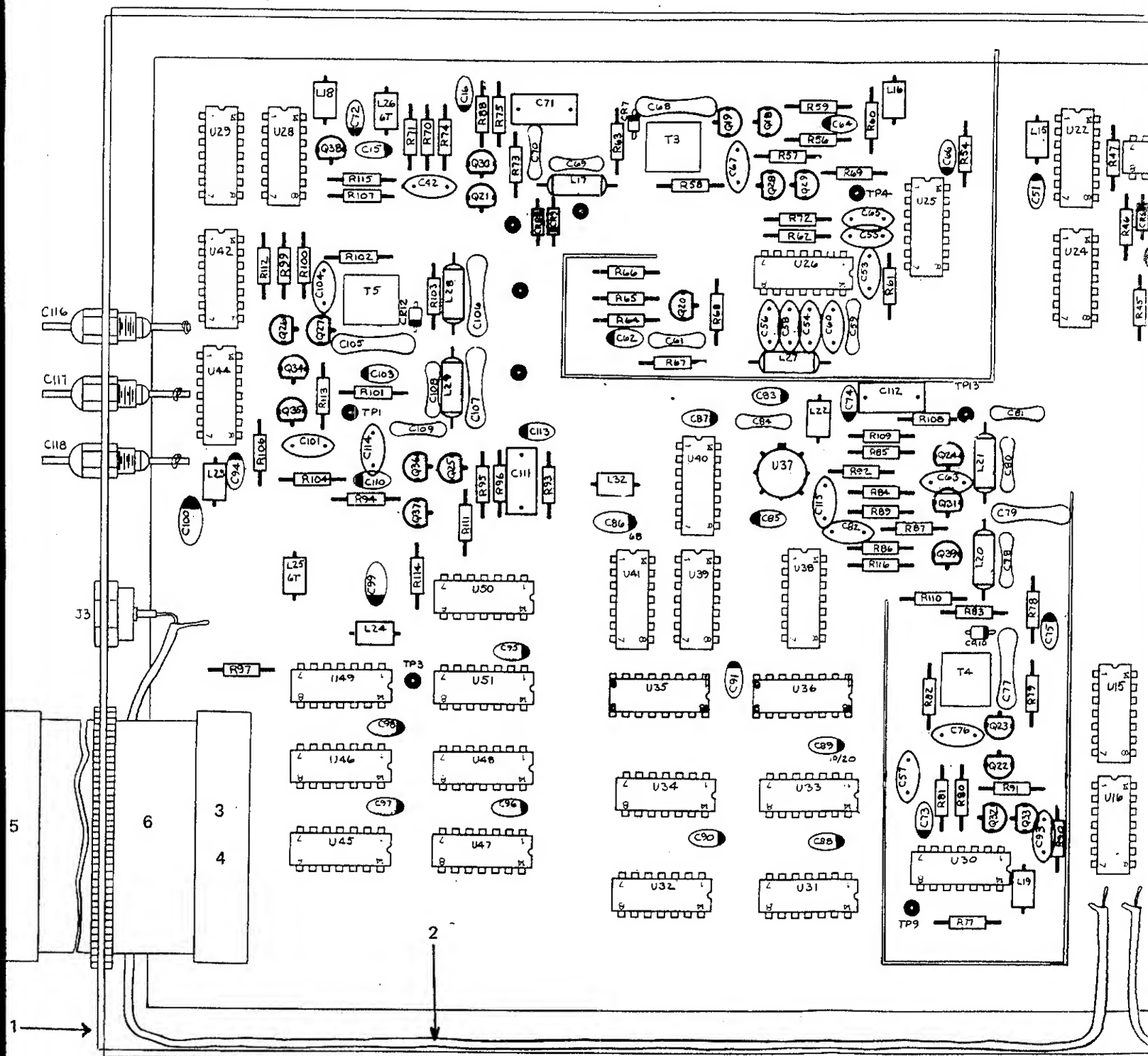


FIG. 5-23
SHT. 3 OF 3

6160B

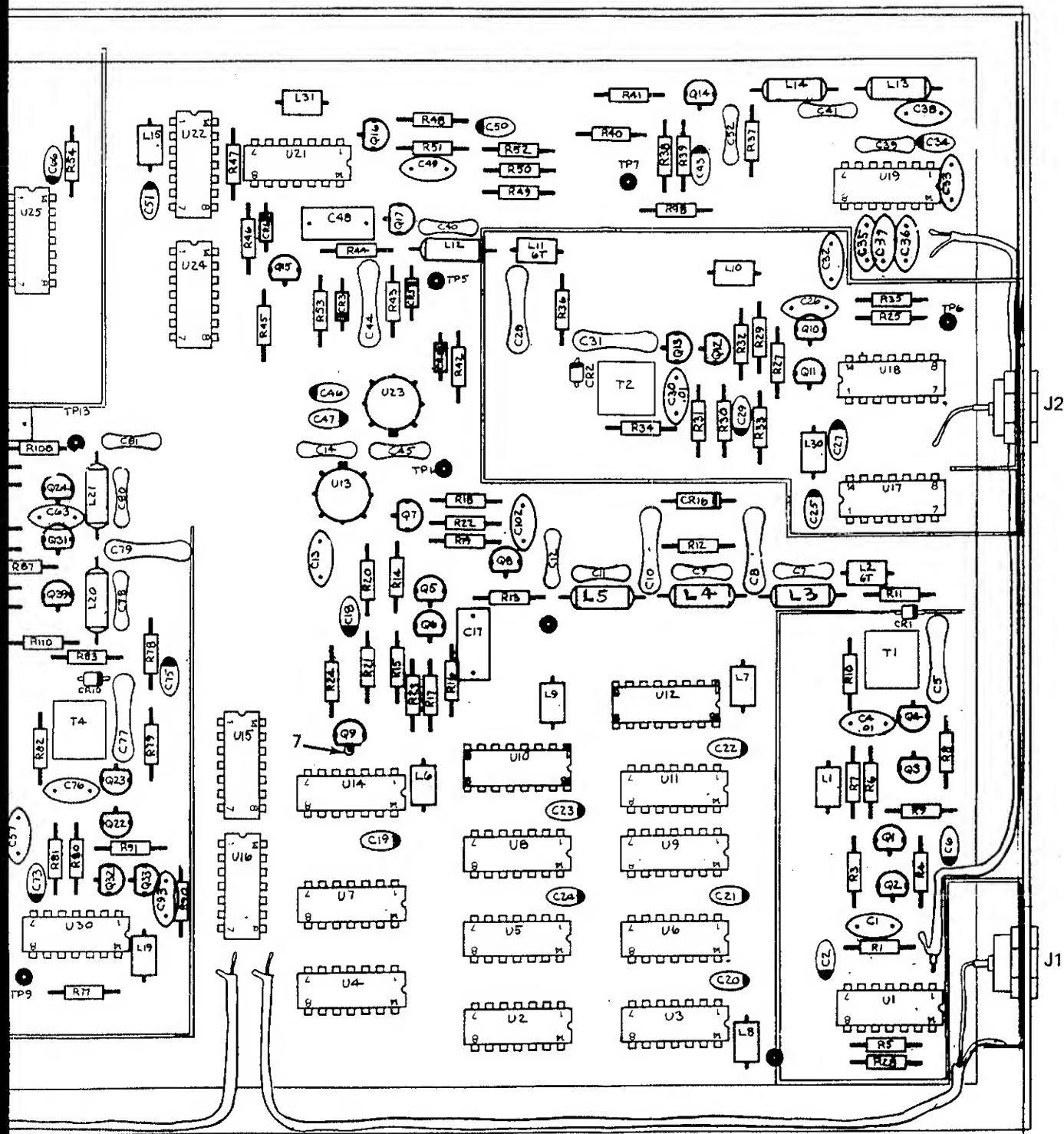


Figure 5-23. SIX DIGIT GENERATOR PCB ASSEMBLY, A9A1

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COMPUTER PCB ASSEMBLY, A10

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10	COMPUTER PCB ASSEMBLY Figure 5-24 6160B - 4012	356287	89536	356287	REF		
C1 thru C9, C11 thru C19	Cap, ta, 2.2 uf, $\pm 2\%$, 20V	161927	56289	196D225X0020	18		
J7	Conn, cable, body Connector, flat cable, 34 contact Conn, cover (not illustrated)	295337 325910 295329	35037 35037 35037	3402 BODY 3424 3402 COVER	1 1 1		
L1	Choke, rf	323816	89536	323816	1		
R1 thru R32	Res, comp, 6.8k, $\pm 10\%$, 1/8W	246967	01121	BB6821	32		
R34	Res, comp, 100 Ω , 1/4W	147926	01121	CB1015	1		
U1 thru U6	IC, DTL, Hex inverter	320853	04713	MC835P	6	2	
U7	IC, DTL, SSI, Hex inverter	268367	04713	MC836P	2	1	
U8	IC, DTL, triple 3-input NAND gate	266312	04713	MC862P -6909	1	1	
U9 thru U12	IC, TTL, Data-selector/multiplexer	320762	01295	SN74151N	4	1	
U13 thru U16	IC, DTL, gate, quad 2-input NAND	268375	04713	MC846P	6	2	
U17, U18, U19	IC, TTL, BCD-to-Binary/Binary to BCD	320697	04713	MC4001P	5	1	
U20	IC, TTL, 4-bit binary counter	320739	01295	SN7493N	1	1	
U21	IC, TTL, BCD to decimal decoders	293142	01295	SN7442N	1	1	
U22	IC, TTL, MSI, dual 4-bit latch	293191	04713	MC8308P	5	1	
U23	IC, TTL, BCD to decimal decoder	293142	01295	SN7442N	1	1	
U25	IC, DTL, SSI, Hex inverter	268367	04713	MC836P	REF		

COMPUTER PCB ASSEMBLY, A10

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U28 thru U31	IC, TTL, MSI, dual 4-bit latch	293191	04713	MC8308P	REF		
U32, U33	IC, DTL, gate, quad 2-input NAND	268375	04713	MC846P	REF		
U34	IC, TTL, dual D-type edge trig.	310227	01295	SN7474N	1	1	
U35	IC, TTL, quad, 2-input NAND gate	292953	01295	SN7400N	1	1	
U36, U37	IC, TTL, BCD-to-Binary/Binary to BCD	320697	04713	MC4001P	REF		
	Bracket hinge	346213	89536	346213	1		
	Cable Assy, #11, 12 (Not illustrated)	270280	89536	270280	1		
	Cable, clamp (Not illustrated)	172080	06383	SST-1	1		
	Cable, flat (Not illustrated)	291807	35037	3350	.84'		
	Conn, post (Not illustrated)	267500	00779	86144-2	102		
	Rivet (Not illustrated)	103424	12014	R3647X5 - 32	3		
	Socket, IC (Not illustrated)	276535	23880	TSA290016W	1		

FIG. 5-24
SHT. 1 OF 3

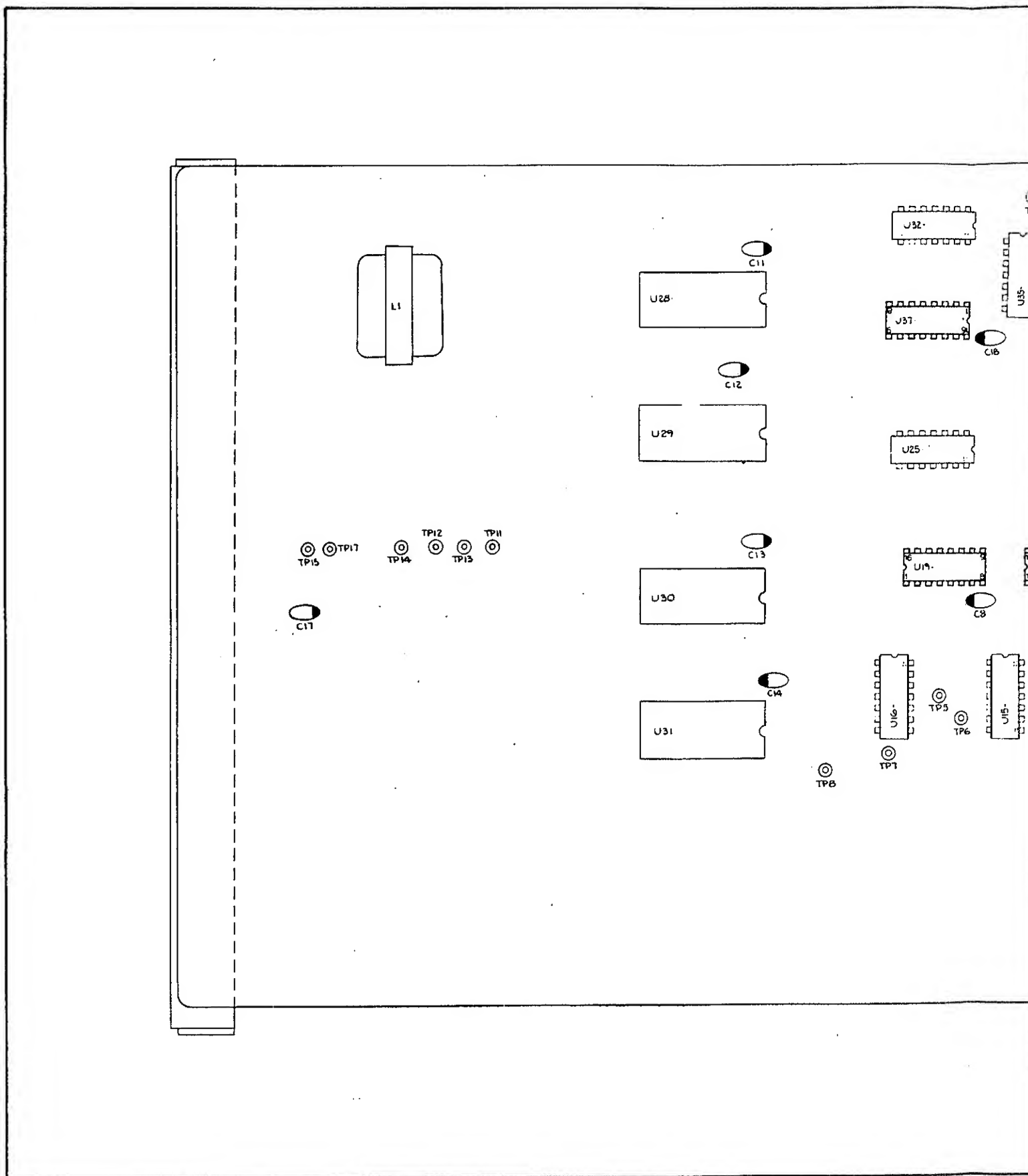


FIG. 5-24
SHT. 3 OF 3

COMPUTER PCB ASSEMBLY

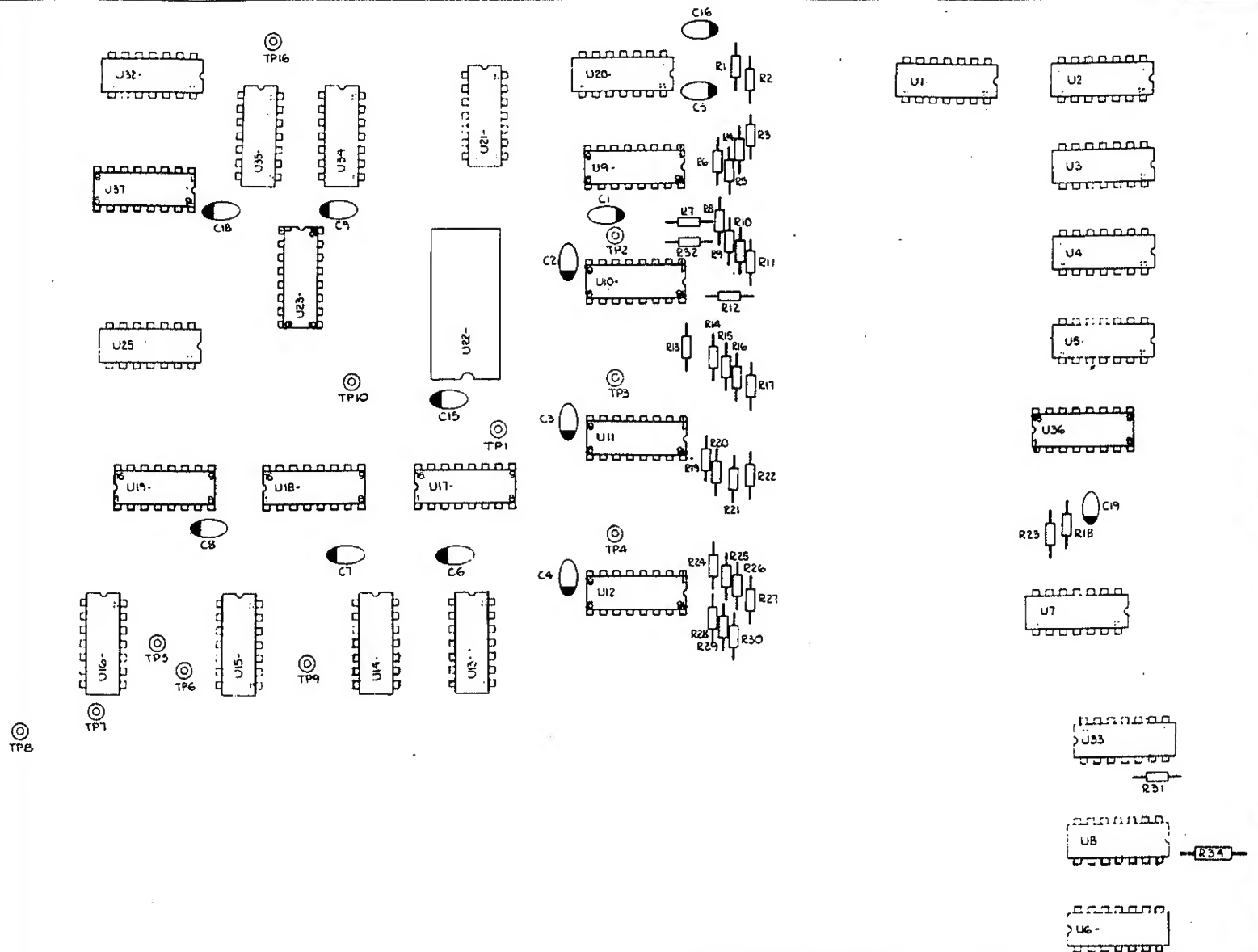


Figure 5-24. COMPUTE

FIG. 5-24
SHT. 3 OF 3

6160B

COMPUTER PCB ASSEMBLY

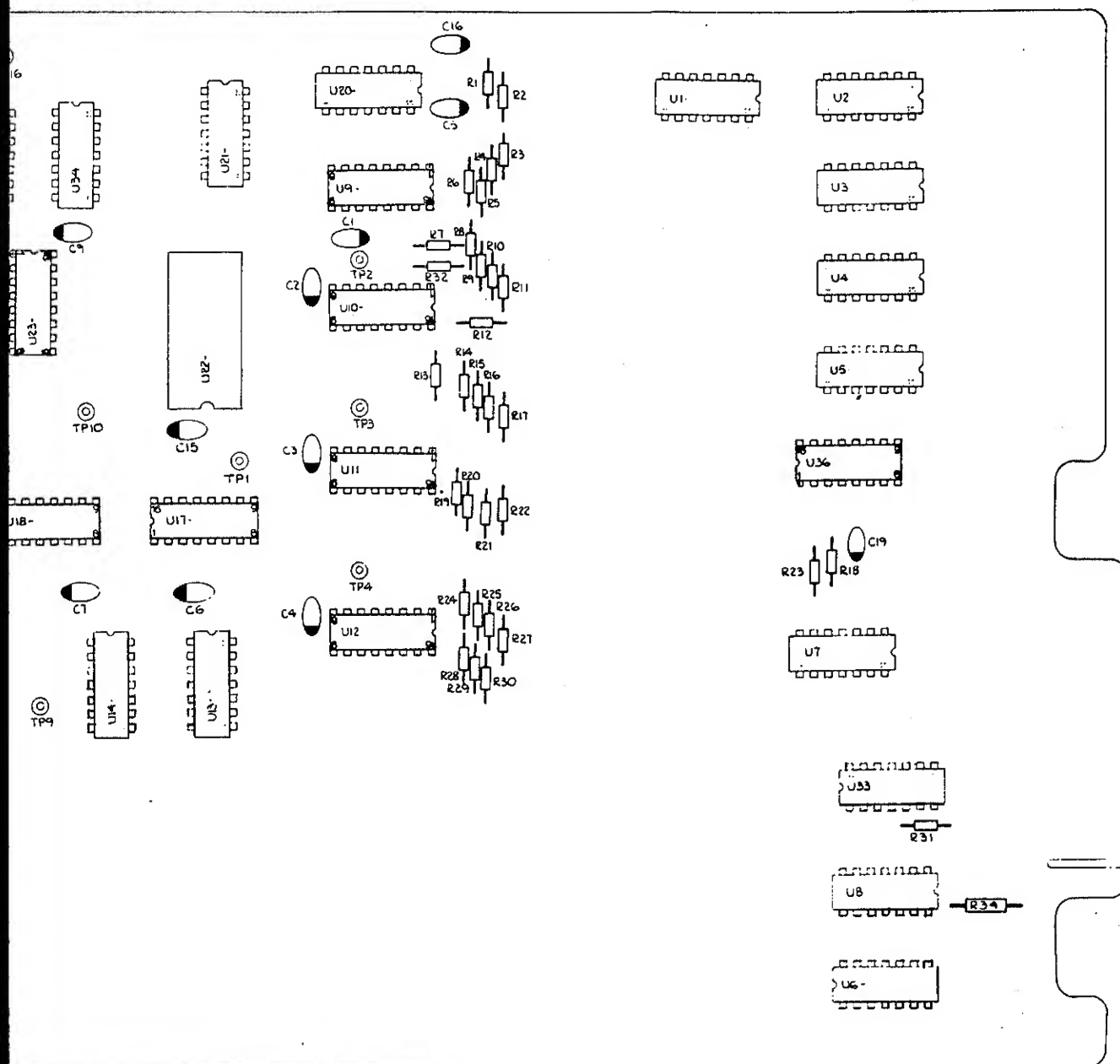


Figure 5-24. COMPUTER PCB ASSEMBLY, A10

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OUTPUT DIVIDER MODULE ASSEMBLY, A11

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A11	OUTPUT DIVIDER MODULE ASSEMBLY 6160A-4111 Figure 5-25	323758	89536	323758	REF		
A11A1	Output Divider PCB Assembly 6160A-4011				1		
1	Module Cover, inner	323238	89536	323238	1		
2	Module cover, outer	323246	89536	323246	1		
3	Screw, 4 - 40 x 1/4 PNH - Phillips	129890	73734	19022	5		
4	Spacer, Hex 4 - 40 x 5/16, Threaded	275503	73734	111410	2		
5	Washer, flat #4	110775	73734	1442	2		
6	Bracket, Module mounting	324590	89536	324590	1		
7	Screw, 4 - 40 x 3/8 PNH - Phillips	152124	73734	19024	2		
8	Clamp, cable	100826	95987	1/4 - 6B	1		
9	Washer, Flat, #4 S. S.	146225	86928	ST10-18-10	1		

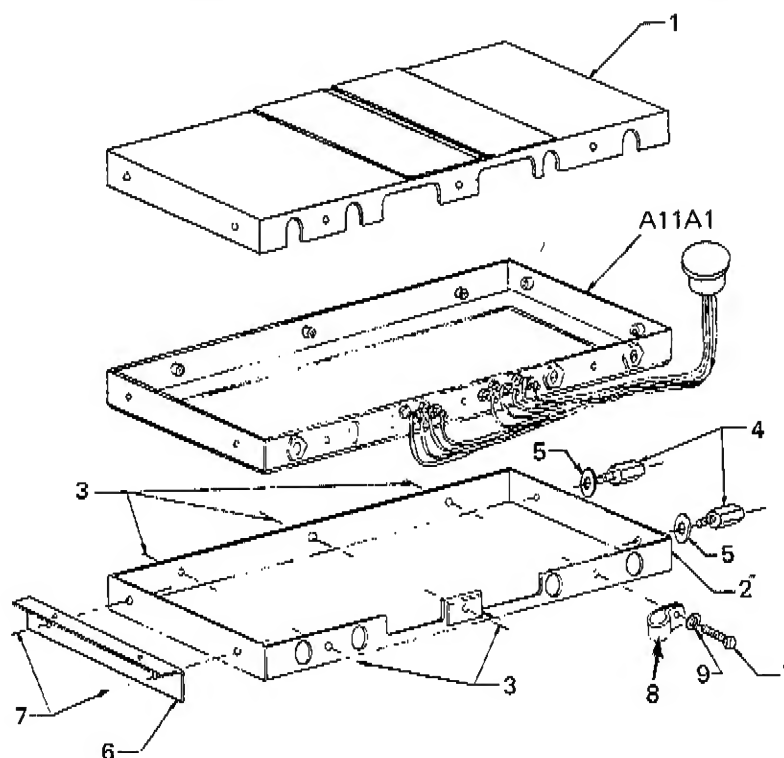


Figure 5-24. OUTPUT DIVIDER MODULE ASSEMBLY, A11

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A11A1	OUTPUT DIVIDER PCB ASSEMBLY Figure 5-26 6160A-4011				REF		
C1 thru C5, C12, C13, C14, C19, C21, C22, C45, C67, C80, C94, C95, C107, C108, C124	Cap, cer, 0.0012 uf $\pm 10\%$, 500V	106732	71590	CF122	19		
C10, C84, C85	Cap, Ta, 0.22 uf $\pm 20\%$, 35V	161331	56289	196D224X0035	3		
C15, C24, C31, C32, C37, C38, C44, C49, C50, C55, C56, C72, C76, C81, C93,	Cap, cer, 0.05 uf $\pm 80/-20\%$, 25V	148942	72982	5855-Y5U-5032	28		

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Cont. C96, C97, C101 thru C106, C116 thru C120	Cap, cer, 0.05 uf $\pm 80/-20\%$, 25V	148942	72982	5855-Y5U- 5032	REF		
C16, C17, C43, C89	Cap, mica, 22 pf $\pm 5\%$, 500V	148551	53021	D15E220J	4		
C18	Cap, mica, 39 pf $\pm 5\%$, 500V	148544	53021	D15E390J	1		
C20 C30	Cap, mica, 33 pf $\pm 5\%$, 500V	160317	53021	D15E330J	2		
C25, C26, C47	Cap, mica, 390 pf $\pm 5\%$, 500V	148437	53021	D15F391J	3		
C27	Cap, mica, 82 pf $\pm 5\%$, 500V	148502	53021	D15E820J	1		
C28, C33, C39, C51, C57, C63	Cap, cer, .01 uf, $\pm 20\%$, 100V	149153	56289	C023B101F 103M	6		
C29	Cap, mica, 56 pf $\pm 5\%$, 500V	148528	53021	D15F560J	1		
C34, C42	Cap, mica, 180 pf $\pm 5\%$, 500V	148460	53021	D15F181J	2		
C35, C111	Cap, mica, 47 pf $\pm 5\%$, 500V	148536	53021	D15E470J	2		
C36	Cap, mica, 130 pf $\pm 5\%$, 500V	266205	53021	D15F131J	1		
C40, C48	Cap, mica, 360 pf $\pm 5\%$, 500V	325878	53021	D15F361J	2		
C41	Cap, mica, 110 pf $\pm 1\%$, 500V	170415	53021	D15F111F	1		
C46	Cap, mica, 510 pf $\pm 5\%$, 500V	148411	53021	D15E511J	1		

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C52	Cap, mica, 1000 pf $\pm 5\%$, 500V	148387	53021	D19F102J	1		
C53	Cap, mica, 270 pf $\pm 5\%$, 500V	148452	53021	D15F271J	1		
C54, C109	Cap, mica, 470 pf $\pm 5\%$, 500V	148429	53021	D19F471	2		
C58	Cap, mica, 2000 pf $\pm 5\%$, 500V	321158	53021	D19F202J	1		
C59	Cap, mica, 560 pf $\pm 5\%$, 500V	170431	53021	D19F561J	1		
C60	Cap, mica, 820 pf $\pm 5\%$, 500V	148395	53021	D19F82DJ	1		
C61, C62, C73, C82, C83, C86, C92, C100, C114	Cap, plstc, 0.1 uf $\pm 10\%$, 250V	161992	73445	C280AE100K	9		
C64	Cap, mica, 3900 pf $\pm 5\%$, 500V	160325	53021	D19F 392J	1		
C65	Cap, mica, 1075 pf $\pm 1\%$, 500V	182899	53021	D19F1075F	1		
C66	Cap, mica, 1800 pf $\pm 5\%$, 500V	148353	53021	D19F182J	1		
C68, C69, C71, C75, C78	Cap, Ta, 2.2 uf $\pm 20\%$, 20V	161927	56289	196D225 X0020	5		
C70 C74, C79	Cap, Ta, 10 uf $\pm 20\%$, 10V	176214	56289	196D 106 X001	3		
C77	Cap, mica, 18 pf $\pm 5\%$, 500V	266585	53021	D15C180J	1		
C87	Cap, mica, 2 pf ± 0.5 , 500V	175208	53021	D15C020D	1		
C88	Cap, var, 1.7 to 010 pf $+70/-20\%$, 250V	321109	73899	DVJ300A	1		
C90, C113	Cap, cer, 6.8 pf ± 0.25 pf, 250V	272518	72982	301000C0H 0689C	2		
C91	Cap, mica, 15 pf $\pm 5\%$, 500V	148569	53021	D15C150J	1		
C110	Cap, mica, 120 pf, $\pm 5\%$, 500V	148486	53021	D15F121J	1		

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C112	Cap, mica, 10 pf, $\pm 5\%$, 500V	175216	53021	D15C100K	1		
C115	Cap, plstc, 1.0 uf, $\pm 10\%$, 250V	190330	73445	C280AE/AM	1		
C121	Cap, elect, 10 uf $+50/-10\%$, 25V	170266	73445	C426ARF10	1	1	
C122	Cap, Ta, 39 uf $\pm 20\%$, 6V	163915	56289	196D396X0006	1		
C123 thru C131	Cap, feed thru	248286	04222	BSF-1BB	9		
CR1 thru CR6	Diode, germanium, 80 mA, 100 piv	149187	93332	1N270	6	2	
CR7, CR13	Diode, pin, silicon	321216	28480	5082-3080	2	1	
CR8, CR9	Diode, silicon, 150 mA	203323	03508	1N4148	2	1	
CR10	Diode, zener, 20 mA	159798	04713	2N 3906	1	1	
CR11, CR12, CR15, CR16	Diode, hot carrier	313247	28480	5082-2811	4	1	
CR14	Diode, silicon, 75V	234450	07910	CD9049	1	1	
CR17, CR19	Diode, silicon, 150 mA	234468	07910	CD9039	2	1	
CR18	Diode, germanium, 50 mA	233197	14433	G1041	1	1	
J1,J2, J4	Conn, male, coaxial	207639	13511	27875	3		
L1,L24	Choke, 0.1 uh $\pm 20\%$	249110	72259	WEE-0-10	2		
L2,L4	Inductor, 0.12 uh $\pm 20\%$, 3350 mA	256289	72259	WEE-0.12	2		
L3	Inductor, 0.1 uh $\pm 10\%$, 3000 mA	257154	24759	MR0.10	1		
L5	Inductor, 0.15 uh $\pm 10\%$, 2600 mA	256297	24759	MR 0.15	1		
L6,L18, L20, L29	Inductor, 0.12 uh $\pm 10\%$, 2860 mA	272617	24759	MR-0.12	4		
L7	Inductor, 0.39 uh $\pm 20\%$, 1420 mA	321026	72259	WEE-.39	1		
L8	Inductor, 0.27 uh $\pm 20\%$, 2000 mA	321018	72259	WEE.27	1		

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
L9	Inductor, 0.47 uh \pm 20%, 1400 mA	248047	72259	WEE-0.47	1		
L10	Inductor, 0.33 uh \pm 20%, 1900 mA	207605	72259	WEE-0.33	1		
L11	Inductor, 0.82 uh \pm 10%, 725 mA	320945	24759	MR - 0.82	1		
L12	Inductor, 0.68 uh \pm 10%, 790 mA	320937	24759	MR - 0.68	1		
L13	Inductor, 1.5 uh \pm 10%, 1420 mA	321034	72259	WEE -1.5	1		
L14	Inductor, 1.2 uh \pm 10%, 2200 mA	245498	72259	WEE- 1.2	1		
L15	Inductor, 3.3 uh \pm 10%, 2030 mA	174714	72259	WEE-3-3	1		
L16	Inductor, 2.2 uh \pm 10%, 1300 mA	207571	72259	WEE-2.2	1		
L17, L19, L21, L22, L23, L30, L33, L34	Bead, 6 turn	320911	89536	320911	8		
L35	Inductor, 2.7 uh \pm 10%, 1130 mA	320978	27459	MR-2.7	1		
L36	Bead, ferrite	219535	02114	56-060-85- 3B	1		
Q1,Q5, Q7,Q9, Q11, Q13, Q15, Q16, 919 Q21, Q23, Q33	Tstr, silicon, NPN	248351	04713	MPS918	12	4	
Q2, Q24, Q29, Q32	Tstr, silicon, NPN	272930	04713	2N5943	4	1	
	Transipad	152207	07047 Ross	10123-DAP	10	2	

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q3, Q6, Q8, Q10, Q12, Q14, Q17, Q18, Q20, Q22	Tstr, silicon, PNP	226290	04713	MPS3640	10	2	
Q25	Tstr, silicon, PNP	229898	04713	MPS6522	1	1	
Q26	Tstr, silicon, NPN	218396	04713	2N3904	1	1	
Q27	Tstr, silicon, PNP	225599	07263	S22650	1	1	
Q28	Tstr, silicon, PNP, dual	242016	11726	QD401-78E	1	1	
Q30, Q31, Q34	Tstr, silicon, PNP	215897	04713	2N4126	3	1	
R1 Thru R5 R15, R74, R77, R109	Res, comp, $51\Omega \pm 5\%$, $\frac{1}{4}W$	221879	01121	CB5105	9		
R6, R106	Res, comp, $22k \pm 5\%$, $\frac{1}{4}W$	148130	01121	CB2235	2		
R7, R93	Res, comp, $47k \pm 5\%$, $\frac{1}{4}W$	148163	01121	CB4735	2		
R12, R13, R59, R78, R80, R89	Res, comp, $15\Omega \pm 5\%$, $\frac{1}{4}W$	147876	01121	CB1505	6		

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R14	Res, comp, $390\Omega \pm 5\%$, $\frac{1}{2}W$	109082	01121	EB3915	1		
R16	Res, met flm, $3.65k \pm 1\%$, $1/8W$	293779	91637	MFF1-83-653F	1		
R17	Res, met flm, $1k \pm 1\%$, $1/8W$	168229	91637	MFF1-81001F	1		
R18, R19, R103	Res, comp, $22\Omega \pm 5\%$, $\frac{1}{4}W$	147884	01121	CB2205	3		
R20, R83	Res, comp, $6.8k \pm 5\%$, $\frac{1}{4}W$	148098	01121	CB6825	2		
R21, R96	Res, comp, $180\Omega \pm 5\%$, $\frac{1}{4}W$	147942	01121	CB1815	2		
R23 thru R28, R30, R31, R32, R54	Res, comp, $5.6\Omega \pm 5\%$, $\frac{1}{4}W$	208033	01121	CB5605	10		
R33, R48, R51	Res, comp, $8.2k \pm 5\%$, $\frac{1}{4}W$	160796	01121	CB8225	3		
R34, R36, R38 thru R44, R49, R50, R52, R53, R55, R56, R65, R108	Res, comp, $470\Omega \pm 5\%$, $\frac{1}{4}W$	147983	01121	CB4715	17		
R35, R37, R47	Res, comp, $270\Omega \pm 5\%$, $\frac{1}{4}W$	160804	01121	CB2715	3		

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R57	Res, comp, $68\Omega \pm 5\%$, $\frac{1}{4}W$	147918	01121	CB6805	1		
R58, R69, R90, R94, R113	Res, comp, $200\Omega \pm 5\%$, $\frac{1}{4}W$	193482	01121	CB2015	5		
R60	Res, comp, $110\Omega \pm 5\%$, $\frac{1}{2}W$	321166	01121	CB1115	1		
R61	Res, comp, $100\Omega \pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	1		
R62, R104	Res, comp, $3.9k \pm 5\%$, $\frac{1}{4}W$	148064	01121	CB3925	2		
R63	Res, comp, $390\Omega \pm 5\%$, $\frac{1}{4}W$	147975	01121	CB3915	1		
R65, R67, R70, R84, R110	Res, comp, $2.2k \pm 5\%$, $\frac{1}{4}W$	148049	01121	CB2225	5		
R66	Res, comp, $33\Omega \pm 5\%$, $\frac{1}{4}W$	175034	01121	CB3305	1		
R68, R79	Res, comp, $1.8k \pm 5\%$, $\frac{1}{4}W$	175042	01121	CB1825	2		
R71	Res, comp, $6.2k \pm 5\%$, $\frac{1}{4}W$	221911	01121	CB6225	1		
R72, R85	Res, comp, $3.3k \pm 5\%$, $\frac{1}{4}W$	148056	01121	CB3325	2		
R73	Res, comp, $100\Omega \pm 5\%$, $\frac{1}{2}W$	188508	01121	EB1015	1		
R75	Res, comp, $5.1k \pm 5\%$, $\frac{1}{4}W$	193342	01121	CB5125	1		
R76 R91	Res, comp, $24k \pm 5\%$, $\frac{1}{4}W$	193433	01121	CB2435	2		
R82 R98, R105, R107	Res, comp, $330\Omega \pm 5\%$, $\frac{1}{4}W$	147967	01121	CB3315	4		
R86	Res, comp, $82\Omega \pm 5\%$, $\frac{1}{2}W$	108746	01121	EB8205	1		

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R87	Res, comp, $27\Omega \pm 5\%$, $\frac{1}{4}W$	160812	01121	CB2705	1		
R88, R112	Res, comp, $39\Omega \pm 5\%$, $\frac{1}{4}W$	193391	01121	CB3905	2		
R92	Res, comp, $3.3\Omega \pm 5\%$, $\frac{1}{4}W$	182279	01121	CB3305	1		
R95	Res, comp, $56\Omega \pm 5\%$, $\frac{1}{4}W$	147900	01121	CB5605	1		
R101	Res, comp, $15k \pm 5\%$, $\frac{1}{4}W$	148114	01121	CB1535	1		
R111	Res, comp, $1k \pm 5\%$, $\frac{1}{4}W$	148023	01121	CB1025	1		
T3,T4	Transformer	253278	89536	253278	2		
T5	Transformer	324400	89536	324400	1		
T6,T7	Transformer	324418	89536	324418	2		
T8	Transformer	324426	89536	324426	1		
U1,U2 U9	IC, DTL, Quad 2-Input NAND Gate	268375	01295	SN15846N	3	1	
U4	IC, ECL, 85 MHz AC coupled j-k flip-flop	320820	04713	MC1032P	1	1	
U5,U6	IC, selected	334771	89536	334771	2		
U7	IC, ECL, dual 3-4 input	320671	04713	MC1026P	1	1	
U8	IC, ECL, D-type, flip-flop	320838	04713	MC1034P	1	1	
U10	IC, selected	334060	89536	334060	1		
XU4, XU5, XU6, XU10	IC, Socket	276535	23880	TSA-2900-16W	4		
1	Harness, Output Divider	332742	89536	332742	1		

OUTPUT DIVIDER PCB ASSEMBLY, A11A1

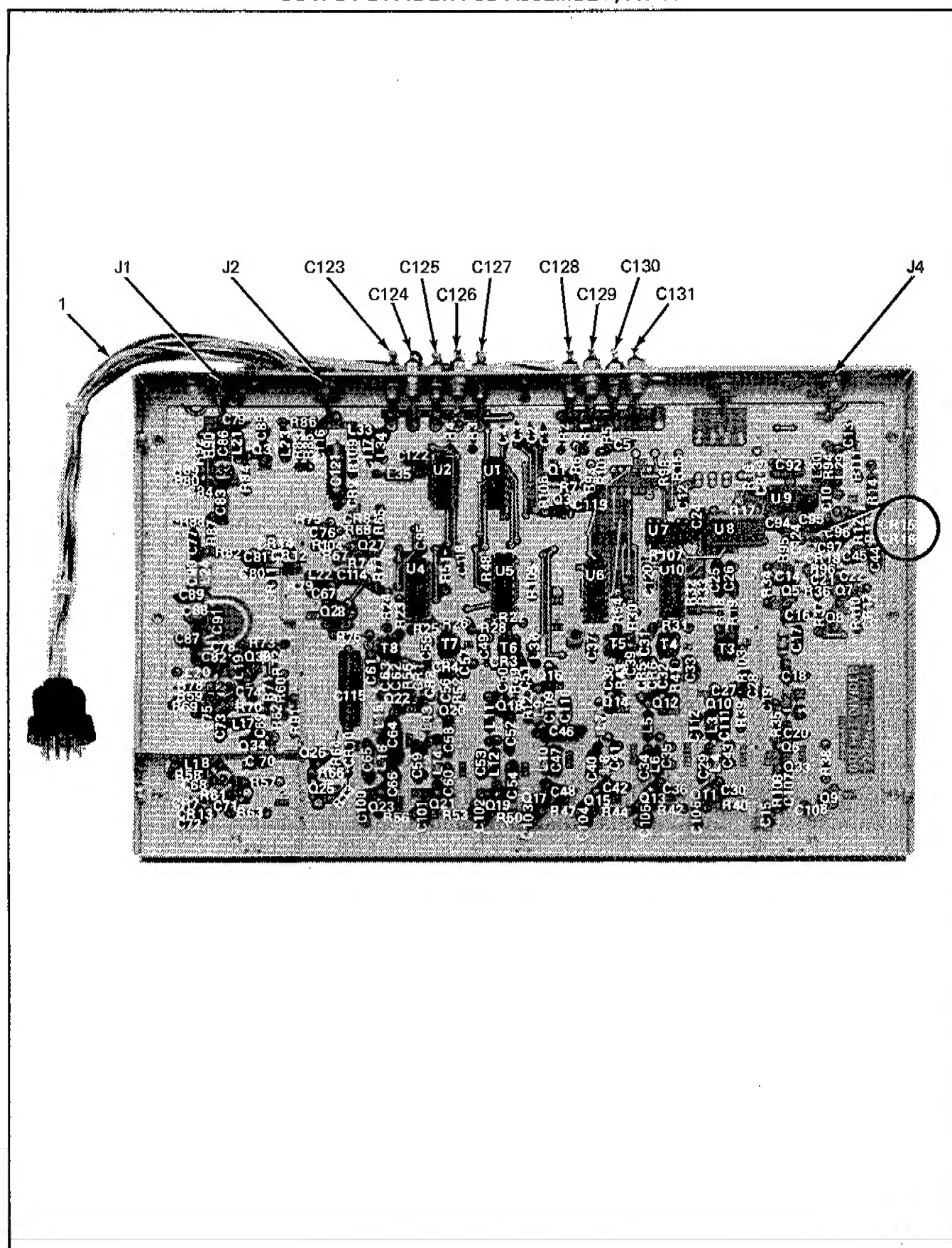


Figure 5-26. OUTPUT DIVIDER PCB ASSEMBLY, A11A1

POWER SUPPLY PCB ASSEMBLY, A12

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A12	POWER SUPPLY PCB ASSEMBLY Figure 5-27 6160A-4014	322933	89536	322933	REF		
C1	Cap, cer, 0.05 uf +80/-20%, 25V	148924	72982	5855-Y5U- 503Z	3		
C2	Cap, electlt, 400 uf +50/-10%, 6.3V	187773	73445	ET471X6P3A6	2	1	
C3, C4	Cap, plstc, 0.1 uf, $\pm 10\%$, 250V	161992	73445	C280AE/A100K	6		
C5, C6, C7	Cap, tant, 68 uf, $\pm 10\%$, 15V	182824	56289	150D686X901 5R2	9		
C8	Cap, plstc, 2.2 uf, $\pm 10\%$, 100V	306522	73445	C280MCH/A 2M12	2		
C9	Cap, mica, 100 pf, $\pm 5\%$, 500V	148494	53021	D15F101J	3		
C10	Cap, cer, 0.05 uf, +80/-20%, 25V	148924	72982	5855-Y5U- 503Z	REF		
C11	Cap, elctlt, 400 uf, +50/-10%, 6.3V	187773	73445	ET471X6P3A6	REF		
C12	Cap, mica, 100 pf, $\pm 5\%$, 500V	148494	53021	D15F101J	REF		
C13, C14	Cap, plstc, 0.1 uf, $\pm 10\%$, 250V	161992	73445	C280AE/A 100K	REF		
C15, C16, C17	Cap, tant, 68 uf, $\pm 10\%$, 15V	182824	56289	150D686X90- 15R2	REF		
C18	Cap, plstc, 2.2 uf, $\pm 10\%$, 100V	306522	73445	C280MCH/A2- M12	REF		
C19	Cap, cer, 0.05 uf, +80/-20%, 25V	148924	72982	5855-Y5U- 503Z	REF		
C20	Cap, mica 100 pf, $\pm 5\%$, 500V	148494	53021	D15F101J	REF		
C21, C22	Cap, plstc, 0.1 uf, $\pm 10\%$, 250V	161992	73445	C280AE/A- 100K	REF		
C23, C24, C25	Cap, tant, 68 uf, $\pm 10\%$, 15V	182824	56289	150D686X90 15R2	REF		
C26	Cap, tant, 68 uf, $\pm 20\%$, 15V	193615	56289	196D686X00 115LA3	1		
CR1	Diode, zener, $\pm 2\%$, 6.2V	325803	15818	TD333408	3	1	

POWER SUPPLY PCB ASSEMBLY, A12

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR2	Diode, zener, $\pm 5\%$, 6.2V	325811	07910	1N753A	6	2	
CR3, CR4, CR6, CR7, CR8	Diode, si, 150 mA	203323	03508	1N4148	12	3	
CR5	Diode, zener, $\pm 10\%$, 15V	246033	07910	1N965A	1	1	
CR9	Diode, zener, $\pm 5\%$, 6.2V	325811	07910	1N753A	REF		
CR10	Diode, zener, $\pm 5\%$, 18V	327973	07910	1N967B	1	1	
CR11	Diode, zener, $\pm 2\%$, 6.2V	325803	15818	TD333408	REF		
CR12	Diode, zener, $\pm 5\%$, 6.2V	325811	07910	1N753A	REF		
CR13, CR14	Diode, si, 150 mA	203323	03508	1N414B	REF		
CR15	Diode, zener, $\pm 5\%$, 13V	110726	07910	1N964B	1	1	
CR16, CR17, CR18	Diode, si, 150mA	203323	03508	1N414B	REF		
CR19	Diode, zener, $\pm 5\%$, 6.2V	325811	07910	1N753A	REF		
CR20	Diode, zener, $\pm 5\%$, 15V	266601	07910	1N965B	1	1	
CR21	See R38, R39	-----	-----	-----	-	-	
CR22	Diode, zener, $\pm 2\%$, 6.2V	325803	15818	TD333408	REF		
CR23	Diode, zener, $\pm 5\%$, 6.2V	325811	07910	1N753A	REF		
CR24	Diode, si, 150 mA	203323	03508	1N4148	REF		
CR25	Diode, zener, $\pm 5\%$, 6V	325795	15818	TD333407	1	1	
CR26	Diode, zener, $\pm 2\%$, 5.6V	325787	15818	TD333406	1	1	
CR28	Diode, zener, $\pm 2\%$, 6.8V	325845	04713	5M6.8ZS2	1	1	
CR29	Diode, zener, $\pm 5\%$, 6.2V	325811	07910	1N753A	REF		
F1	Fuse, fast acting, 4 amp	216846	71400	AGC4A250V	1	5	
L1, L2	Inductor, 15 mh	182964	72259	WEE-15,000	2		

POWER SUPPLY PCB ASSEMBLY, A12

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q1, Q2, Q3, Q5, Q9, Q11, Q12, Q13	Xstr, si, PNP	195974	04713	2N3906	8	2	
Q4, Q6, Q7, Q8, Q10, Q14, Q15	Xstr, si, NPN	218396	04713	2N3904	7	2	
R1	Res, comp, 1.8K, $\pm 5\%$, $\frac{1}{2}W$	109140	01121	EB1825	5		
R2	Res, mtl flm, 1.43K, $\pm 1\%$, 1/8W	325662	91637	MFF1-81431F	3		
R3	Res, mtl flm, 261 Ω , $\pm 1\%$, 1/8W	328013	91637	MFF1-82610F	1		
R4	Res, fxd WW, 1 Ω , $\pm 1\%$, 150V, 2W	229534	91637	RS2C70GF	2		
R5	Res, mtl flm, 1.10K, $\pm 1\%$, 1/8W	241497	91637	MFF1-81101F	3		
R6	Res, comp, 1.8K, $\pm 5\%$, $\frac{1}{2}W$	109140	01121	EB1825	REF		
R7	Res, comp, 130 Ω , $\pm 5\%$, $\frac{1}{4}W$	325704	01121	CB1315	3		
R8	Res, comp, 3.3K, $\pm 5\%$, $\frac{1}{2}W$	165761	01121	EB3325	2		
R9	Res, comp, 1K, $\pm 5\%$, $\frac{1}{2}W$	108597	01121	EB1025	1		
R10	Res, comp, 4.7K, $\pm 5\%$, $\frac{1}{4}W$	148072	01121	CB4725	1		
R11	Res, comp, 51 Ω , $\pm 5\%$, $\frac{1}{4}W$	221879	01121	CB5105	3		
R12	Res, comp, 12K, $\pm 5\%$, $\frac{1}{4}W$	159731	01121	CB1235	2		
R13	Res, comp, 100 Ω , $\pm 5\%$, $\frac{1}{4}W$	147926	01121	CB1015	2		
R14	Res, fxd, WW, 0.15 Ω , $\pm 10\%$, 2W	325712	81483	BWHR15K	2		
R15	Res, mtl flm, 6.49K, $\pm 1\%$, 1/8W	294900	91637	MFF1-86491F	1		
R16	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}W$	148015	01121	CB8215	3		
R17	Res, comp, 3 Ω , $\pm 5\%$, $\frac{1}{4}W$	218040	01121	CB30G5	3		
R18, R19	Res, dual, WW, 11.85K X 14K, 1W (2 on 1)	325183	89536	325183	1		

POWER SUPPLY PCB ASSEMBLY, A12

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R20	Res, mtl flm, 100 Ω , $\pm 1\%$, 1/8W	168195	91637	MFF1-81000F	1		
R21	Res, var, CERMET, 100 Ω , $\pm 10\%$, 1/2W	285130	71450	360S-101A	1		
R22	Res, comp, 1.8K, $\pm 5\%$, 1/2W	109140	01121	EB1825	REF		
R23	Res, mtl flm, 1.43K, $\pm 1\%$, 1/8W	325662	91637	MFF1-81431F	REF		
R24	Res, mtl flm, 237 Ω , $\pm 1\%$, 1/8W	328005	91637	MFF1-82370F	1		
R25	Res, fxd WW, 1 Ω , $\pm 1\%$, 150V, 2W	229534	91637	RS2C70GF	REF		
R26	Res, mtl flm, 1.10K, $\pm 1\%$, 1/8W	241497	91637	MFF1-81101F	REF		
R27	Res, comp, 1.8K, $\pm 5\%$, 1/2W	109140	01121	EB1825	REF		
R28	Res, comp, 130 Ω , $\pm 5\%$, 1/4W	325704	01121	CB1315	REF		
R29	Res, comp, 3.3K, $\pm 5\%$, 1/2W	165761	01121	EB3325	REF		
R30	Res, comp, 1.3K, $\pm 5\%$, 1/2W	109157	01121	EB1325	1		
R31	Res, comp, 3.9K, $\pm 5\%$, 1/4W	148064	01121	CB3925	1		
R32	Res, comp, 51 Ω , $\pm 5\%$, 1/4W	221879	01121	CB5105	REF		
R33	Res, comp, 12K, $\pm 5\%$, 1/4W	159731	01121	CB1235	REF		
R34	Res, comp, 100 Ω , $\pm 5\%$, 1/4W	147926	01121	CB1015	REF		
R35	Res, fxd, WW, 0.15, $\pm 10\%$, 2W	325712	81483	BWHR15K	REF		
R36	Res, comp, 820 Ω , $\pm 5\%$, 1/4W	148015	01121	CB8215	REF		
R37	Res, comp, 3 Ω , $\pm 5\%$, 1/4W	218040	01121	CB30G5	REF		
R38, R39, CR21	Reference Assembly	325266	89536	325266	1		
R40	Res, var, CERMET, 50 Ω , $\pm 10\%$, 1/2W	285122	71450	360S-500A	1		
R41	Res, mtl flm, 2.80K, $\pm 1\%$, 1/8W	325670	91637	MFF1-82801F	1		
R42	Res, mtl flm, 866 Ω , $\pm 1\%$, 1/2W	151233	91637	MFF1-2660	1		
R43	Res, comp, 1.8K, $\pm 5\%$, 1/2W	109140	01121	EB1825	REF		
R44	Res, mtl flm, 1.43K, $\pm 1\%$, 1/8W	325662	91637	MFF1-81431F	REF		
R45	Res, mtl flm, 210 Ω , $\pm 1\%$, 1/8W	327999	91637	MFF1-82100F	1		
R46	Res, WW, 0.27 Ω , $\pm 1\%$, 5W	325696	11502	AS-5	1		
R47	Res, fxd WW, 1 Ω , $\pm 1\%$, 150V, 2W	229534	91637	RS2C70GF	REF		

POWER SUPPLY PCB ASSEMBLY, A12

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R48	Res, comp, 2.7K, $\pm 5\%$, 1W	296422	01121	GB2725	1		
R49	Res, comp, 130 Ω , $\pm 5\%$, $\frac{1}{4}$ W	325704	01121	CB1315	REF		
R50	Res, comp, 510 Ω , $\pm 5\%$, $\frac{1}{4}$ W	218032	01121	CB5115	1		
R51	Res, comp, 1.2K, $\pm 5\%$, $\frac{1}{4}$ W	190371	01121	CB1225	1		
R52	Res, comp, 51 Ω , $\pm 5\%$, $\frac{1}{4}$ W	221879	01121	CB5105	REF		
R53	Res, comp, 620 Ω , $\pm 5\%$, $\frac{1}{4}$ W	221903	01121	CB6215	1		
R54	Res, comp, 2 Ω , $\pm 5\%$, $\frac{1}{4}$ W	202879	01121	CB2025			
R55, R56	Res, fxd, WW, 0.30 Ω , $\pm 5\%$, 2W	219410	75042	BWHR30J	2		
R57	Res, comp, 820 Ω , $\pm 5\%$, $\frac{1}{4}$ W	148015	01121	CB8215	REF		
R58	Res, comp, 3 Ω , $\pm 5\%$, $\frac{1}{4}$ W	218040	01121	CB30G5	REF		
R59	Res, mtl flm, 4.99K, $\pm 25\%$, $\frac{1}{4}$ W	267625	91737	MFF1-44991P	1		
R60	Res, mtl flm, 11.8K, $\pm 1\%$, 1/8W	325688	91632	MFF1-81182F	1		
R61	Res, mtl flm, 200 Ω , $\pm 1\%$, 1/8W	245340	91637	MFF1-82000F	1		
U1, U2, U3	IC, operational amplifier	271502	07263	LM301A	3	1	
	Xstr Pad	296319	32559	T0806	4		

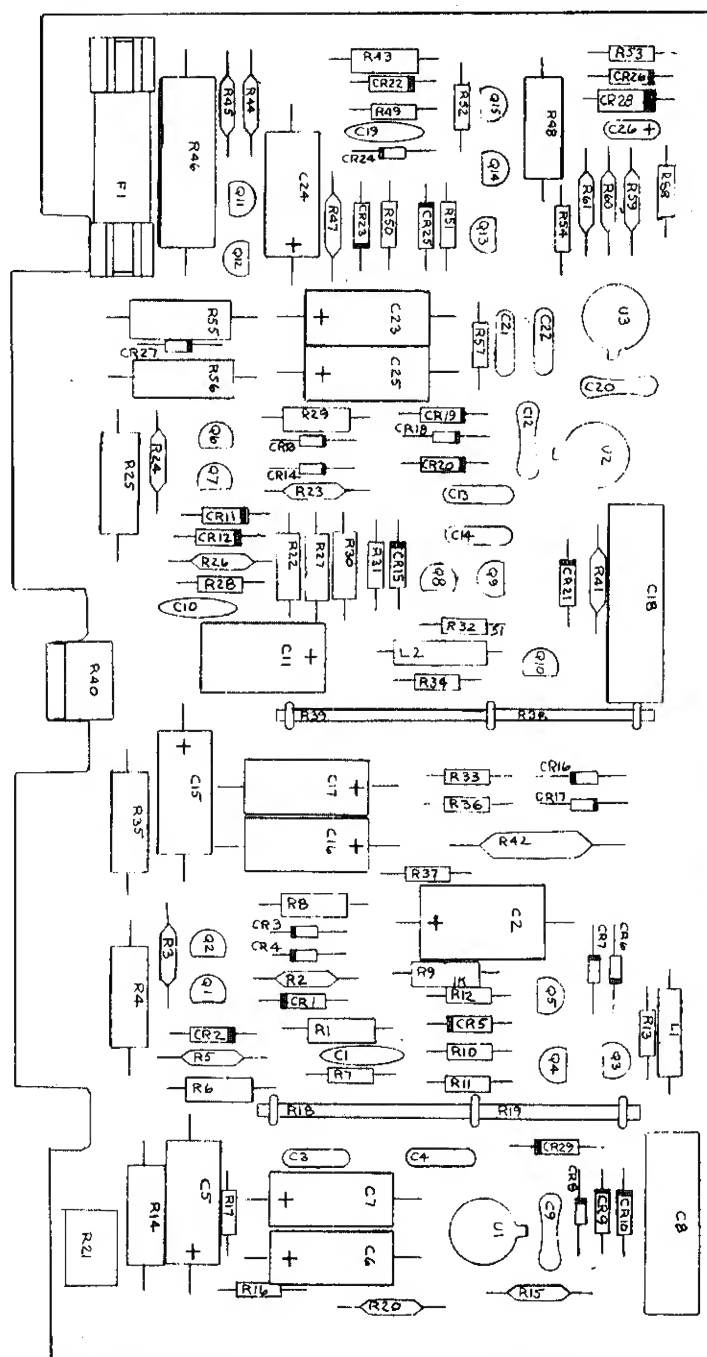


Figure 5-27. POWER SUPPLY PCB ASSEMBLY, A12

MOTHER BOARD PCB ASSEMBLY, A13

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A13	MOTHER BOARD PCB ASSEMBLY Figure 5-28 6160B-4013	356295	89536	356295	REF		
J10 thru J13	Connector, rcpt. 20 pin	292912	02660	225-21021-110	5		
CR1 thru CR4	Diode, si, 3 Amp	187716	04713	MR1032B/ 1N4999	4	1	
CR5, CR6	Diode, si, rectifier	325746	04713	MR751	2	1	
J15	Socket, tube	100495	95354	PM465	1		
	Terminal post	267500	00779	86144-2	34		

MOTHER BOARD PCB ASSEMBLY, A13

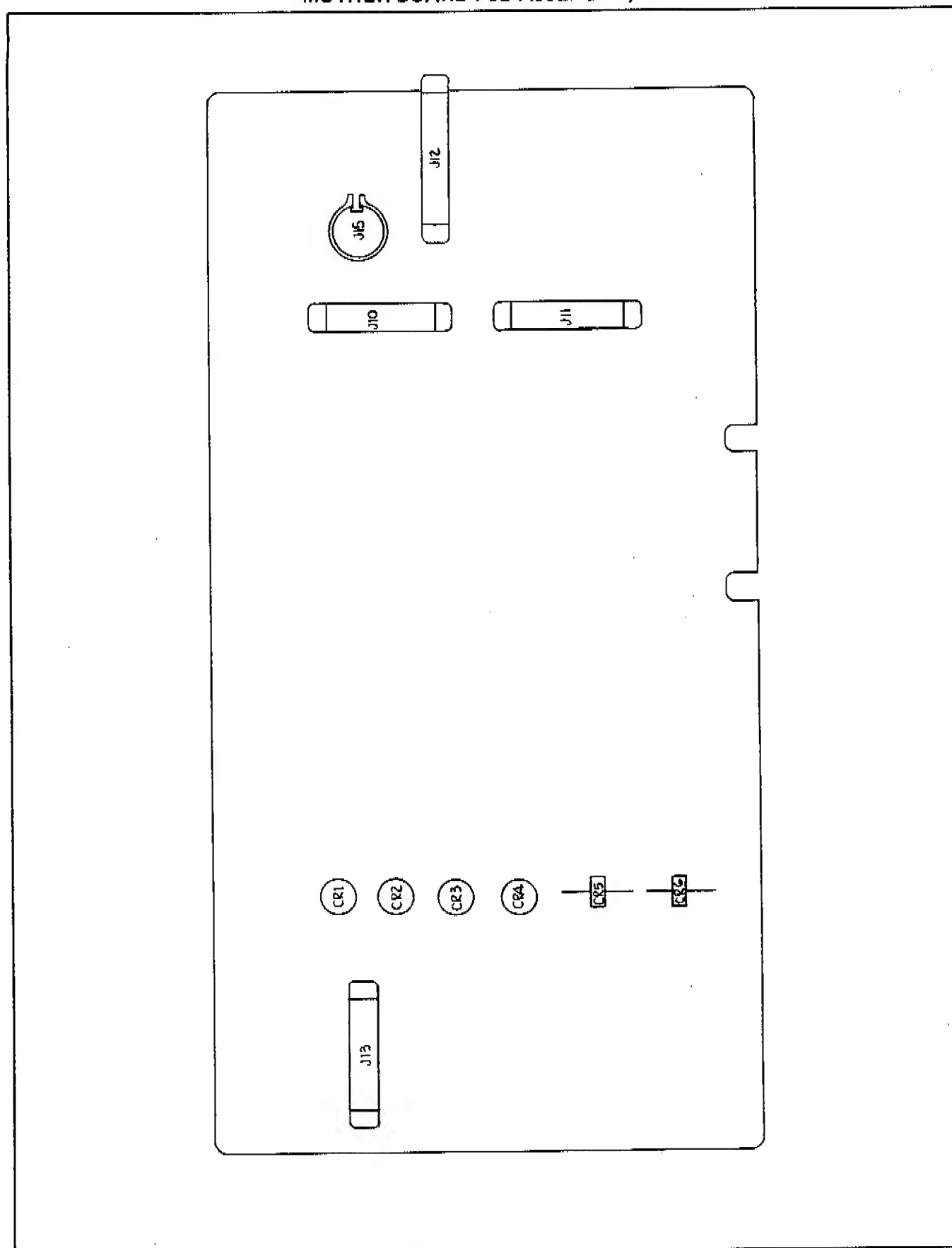


Figure 5-28. MOTHER BOARD PCB ASSEMBLY, A13

RISER PCB ASSEMBLY, A14

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A14	RISER PCB ASSEMBLY Figure 5-29 6160A-4015	323147	89536	323147	REF		
J1, J2	Connector, 20 pin contact	292912	72660	225-21021-110	2		

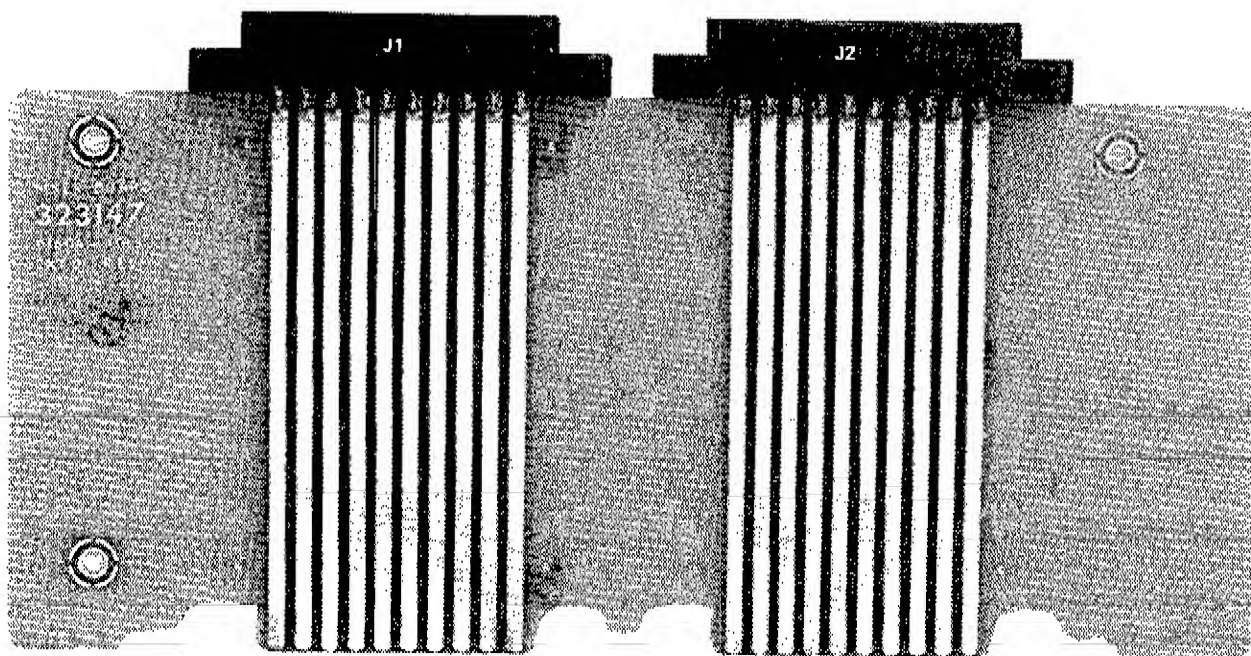


Figure 5-29. RISER PCB ASSEMBLY

TRANSFORMER ENCLOSURE ASSEMBLY, A15

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A15	TRANSFORMER ENCLOSURE ASSEMBLY 6160A-4116 Figure 5-30	323493	89536	323493	REF		
C1, C2, C3, C4	Cap, cer, 0.005 uf \pm 20%, 1000V	105650	56289	C023B102H- 502M	4		
F1, F2	Fuse, slo-blo, 1.5A	109231	71400	MDS1R5A250V	2	5	
FL1	Filter, line, 3A	321273	05245	3EF2	1		
S1	Switch, 115/230V	226274	82389	46256-LFR	1		
T1	XFmr, power	324434	89536	324434	1		
XF1, XF2	Fuse holder	160846	75915	342004	2		
1	Nut, kep, #8 - 32	195263	78199	51108180000	6		
2	Nut, kep, #6 - 32	195263	78199	51106180000	2		
3	PCB, xfmr connector	323642	89536	323642	1		
4	Screw, 6 - 32 x 3/8, FLH - Phillips	114363	73734	18244	6		
5	Screw, 8 - 32 x 3/8, FLH - Phillips	114116	73734	18264	4		
6	Screw, 8 - 32 x 3/8, PNH - Phillips	114124	73734	19064	4		
7	Screw, 6 - 32 x 3/8, SEMS	177022	73734	6-32 x 3/8 SEMS	4		
8	xfmr enclosure	323345	89536	323345	1		
9	xfmr enclosure, top	323352	89536	323352	1		

TRANSFORMER ENCLOSURE ASSEMBLY, A15

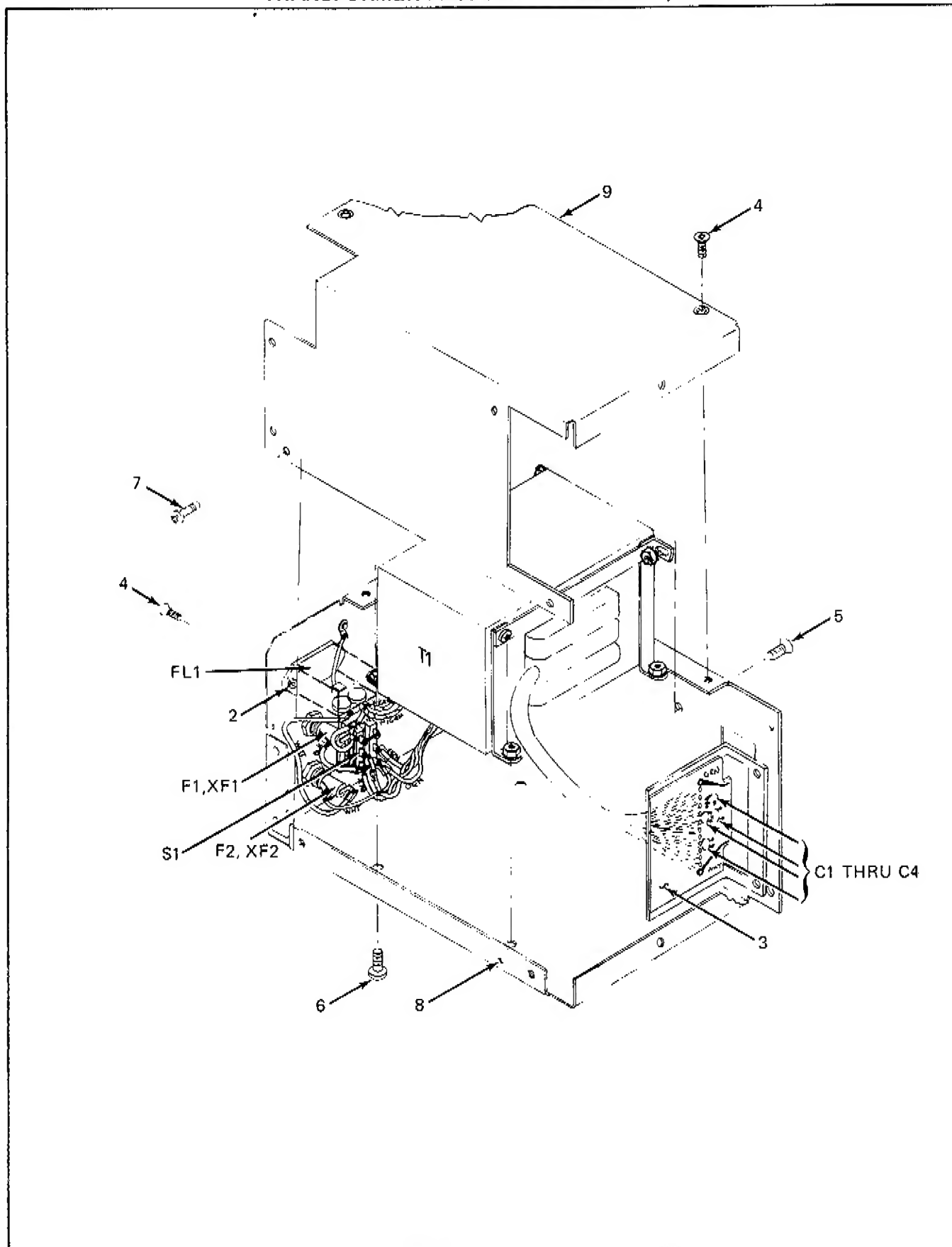


Figure 5-30. TRANSFORMER ENCLOSURE ASSEMBLY, A15

HEAT SINK ASSEMBLY, A16

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A16	HEAT SINK ASSEMBLY Figure 5-31 6160A-4021	323154	89536	323154	REF		
J1	Connector, board-edge, receptical, 20 pin	292912	02660	225-21021-110	1		
Q1,Q5	Xstr, si, NPN	325720	04713	MJE3055	2	1	
Q2,Q6	Xstr, si NPN	325761	06001	D4465	2	1	
Q3	Xstr, si, PNP	325738	04713	MJE2955	1	1	
Q4	Xstr, si, PNP	325753	06001	D4565	1	1	
R1, R2, R3	Res, comp, 620 Ω , $\pm 5\%$, 1/4W	221903	01121	CB6215	3		
1	Heat sink	252684	89536	252684	1		
2	Insulator, xstr mounting	331116	13103	4778A	3		
3	Lug, solder, #6	132399	78189	2104-06-00	1		
4	Screw, 4-40 x 1, PNH - Phillips	157008	73734	12030	2		
5	Screw, 6-32 x 1/4, PNH - Phillips	152140	73734	19042	1		
6	Screw, nylon with steel core, 6-32 x 1/4, RDH - Phillips	272799	23050	6-32x1-4NYL STLRDH	3		
7	Screw, 6-32 x 3/8, PNH - Phillips	152165	73734	19044	3		
8	Standoff, insulator, #6	163592	89536	163592	2		
9	Washer, flat, #4	110775	73734	1442	2		
10	Washer, internal lock, #4	110403	73734	99402	2		
11	Washer, flat, #6	110270	73734	AN960-616L	1		

HEAT SINK ASSEMBLY, A16

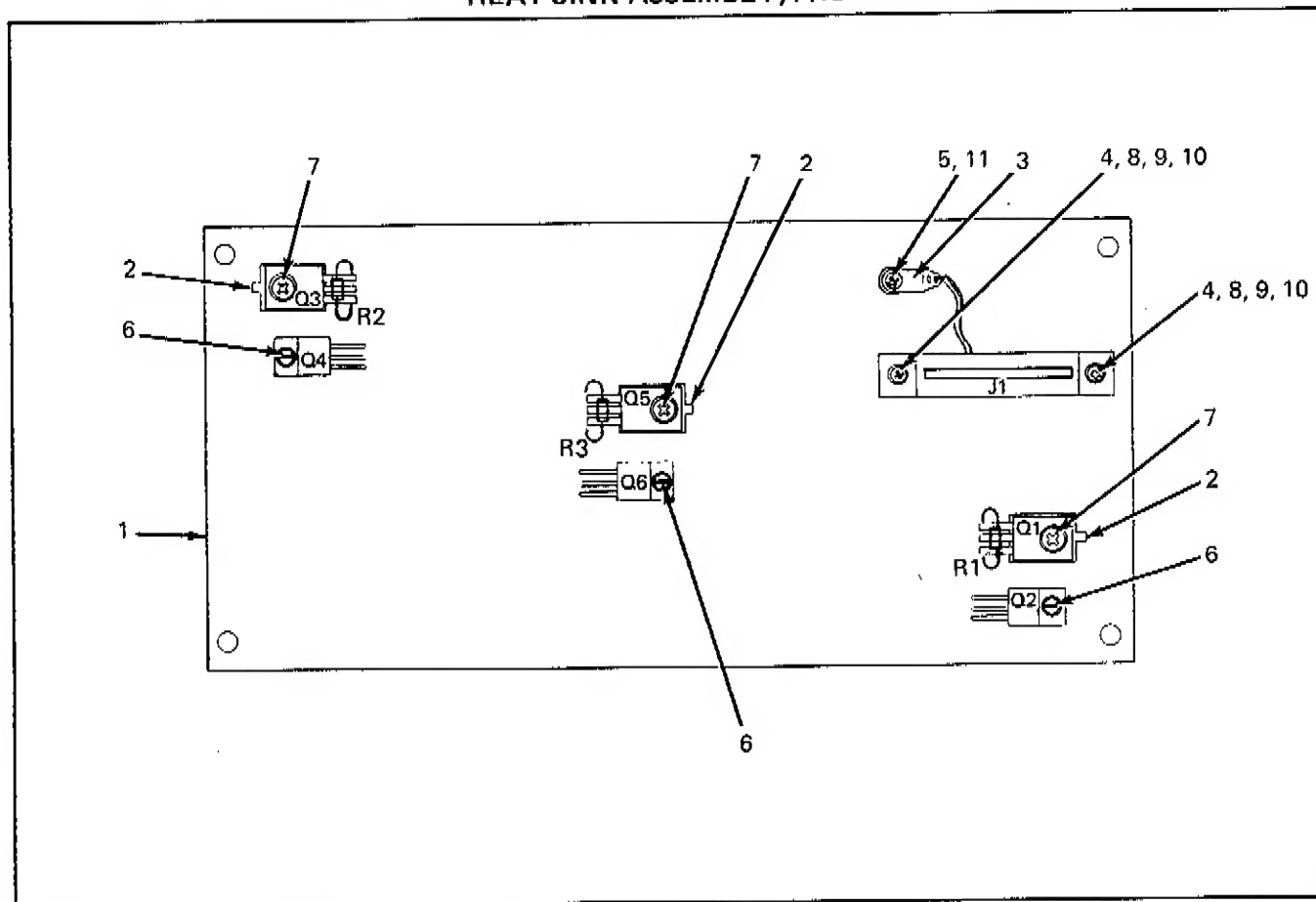


Figure 5-31. HEAT SINK ASSEMBLY, A16

REAR PANEL ASSEMBLY, A17

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A17	REAR PANEL ASSEMBLY Figure 5-32 6160A-4452	324616	89536	324616	REF		
1	Rear Panel, screened	323337	89536	323337	1		
2	Washer, flat #8	110288	73734	97425	4		
3	Foot, rear	324897	89536	324897	4		
4	Screw, 8 - 32 x 5/8 PNH - Phillips	114983	73734	19067	4		
5	Washer, internal lock, #8	110320	73734	99405	4		
6	Hole plug - 5/8"	222711	72653	1713 - C	1		
7	Hole plug - 1/2"	101774	72653	1712 - C	2		
8	Screw, 6 - 32 x 1/4, PNH - Phillips (SEMS)	178533	73734	6-32x1-4PNH SEMS	4		
9	Bracket, card slide	323287	89536	323287	1		
10	Connector, BNC, LEVEL CONTROL INPUT	152033	95712	30355-1	1		
11	Cable Assy, RF #2	259747	89536	259747	1		
12	Cable Assy, RF #1	269969	89536	269969	1		
13	Cable Assy, RF #24	270264	89536	270264	1		
14	Cable Assy, RF #23	333096	89536	333096	1		

REAR PANEL ASSEMBLY, A17

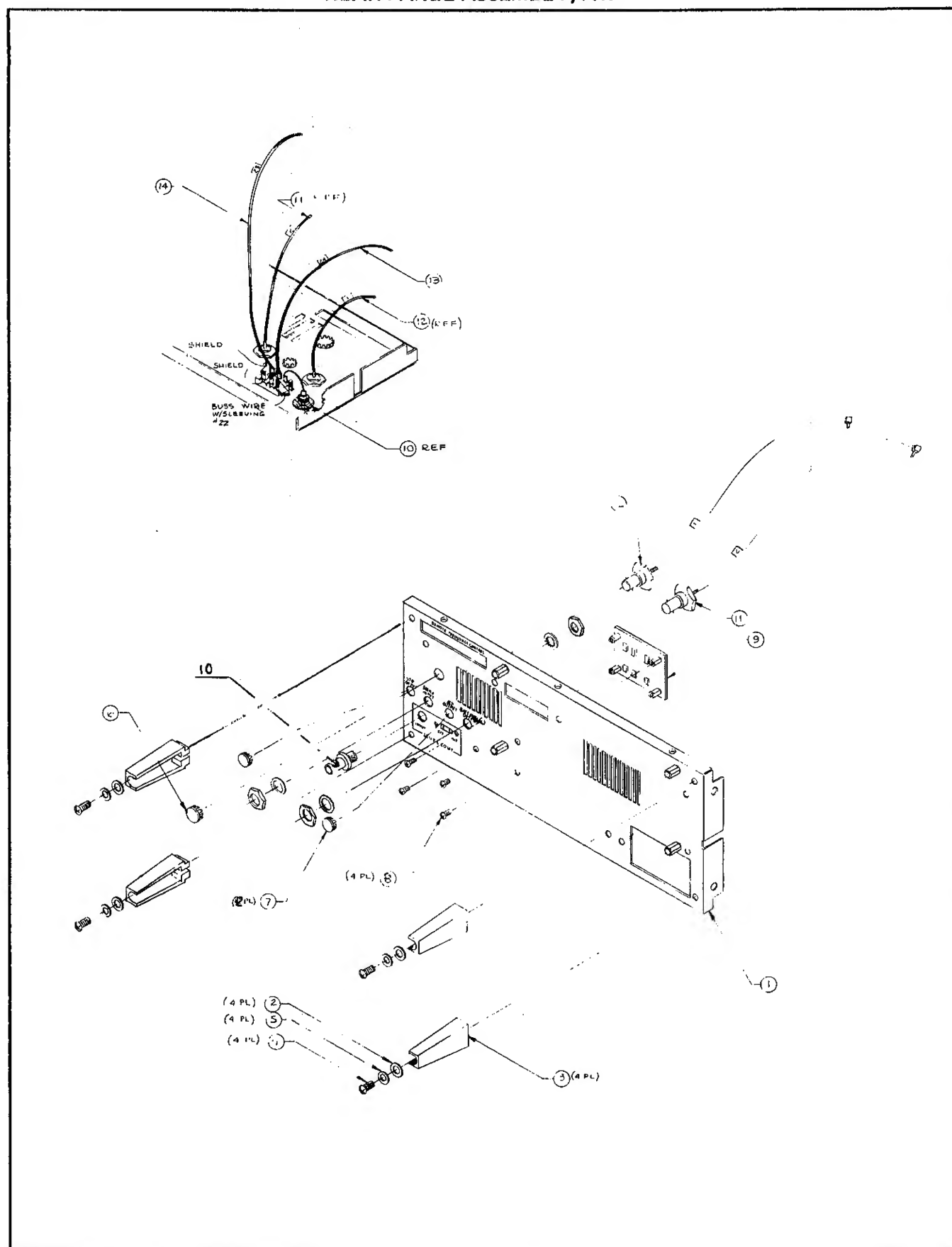


Figure 5-32. REAR PANEL ASSEMBLY, A17

Section 6

Option & Accessory Information

6-1. FREQUENCY STANDARD, OPTION -02**6-2. Introduction**

6-3. The -02 Option is a 5 MHz oscillator assembly with a rated stability of 2 parts in 10^9 per 24 hours. The oscillator eliminates the need for an external 5 MHz source to drive the synthesizer. The oscillator is ovenized for stability and temperature is maintained as long as ac power is connected to the unit.

6-4. Operation

6-5. Operation of the 6160B with the -02 Option installed is the same as that described in Section 2 for the standard unit, except that no external 5 MHz source need be applied. The 5 MHz oscillator is automatically maintained at operating temperature when the front-panel FUNCTION switch is in the OFF position, as long as ac power is connected.

6-6. Theory of Operation

6-7. Although the oscillator itself is considered non-

repairable, the operation of the associated pcb is repairable, and is described in the following text with reference to the A15, Internal Frequency Standard (Option -02) schematic diagram, drawing 6160A-1018. During normal operation, the 5 MHz oscillator operates from the regulated +14-volt and -12-volt supplies. The unregulated +14-volt supply is disconnected by means of Q1, which is cut-off by the front-panel FUNCTION switch.

6-8. When the FUNCTION switch is placed in the OFF position, Q1 conducts to apply the +14-volt unregulated supply to the oscillator oven in order to maintain temperature. Diode CR3 prevents the +14-volt unregulated supply from feeding circuits normally powered by the +14-volt regulated supply.

6-9. List of Replaceable Parts

6-10. For column entry explanations, part ordering information and basic instrument configuration, refer to Section 5 of the manual.

REF DESIG	DESCRIPTION	STOCK NUMBER	TOT QTY	REC QTY	USE CODE
A15	INTERNAL FREQUENCY STANDARD ASSY. -01, -02 OPTION, (6160A-4018) Figure 5-16				
	-02 Option, 2×10^{-9} per day drift rate	315440	REF		
A15A1	5 MHz standard oscillator (-02 Option)	285577	1		
A15A2	Frequency standard assembly	324822	1		
	Cable, coax, Jumper assembly	172809	1		
	Cable, RF, assembly	259705	1		
A15A2	FREQUENCY STANDARD ASSEMBLY	324822	REF		
C1, C2	Cap, cer, 0.05 uf +80/-20%, 25V	148924	2		
CR1, CR2, CR3	Diode, silicon, 1 amp, 100 piv	116111	3		
L1, L2	Bead, 6 turn	320911	2		
Q1	Tstr, silicon, PNP	218537	1		
R1	Res, comp, 1k $\pm 5\%$, 1/4w	148023	1		
R2	Res, comp, 1.5k $\pm 5\%$, 1/4w	148031	1		
XY1	Socket, tube	100479	1		
	Cable, RF	259705	1		

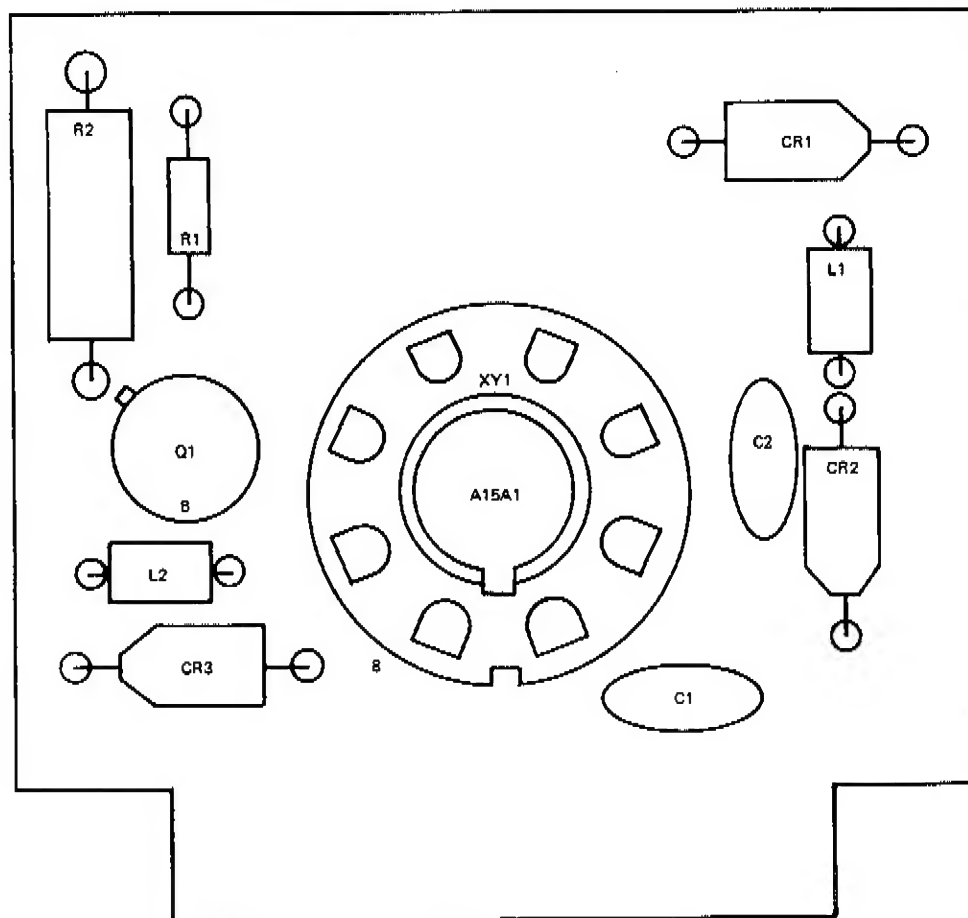


Figure 6-1. INTERNAL FREQUENCY STANDARD ASSEMBLY, -02 OPTION

6-11. REAR PANEL RF OUTPUT, OPTION -04

6-12. The --04 option comprises an rf cable and output connector mounted on the rear panel, in place of the standard output connector on the front panel. The rf output characteristics and specifications for the rear panel connector are identical to those specified for the standard front panel rf output connector.

6-13. TCXO, OPTION -05

6-14. The --05 Option for the 6160B is a 5 MHz TCXO (temperature compensated crystal oscillator) which has a specified stability of five parts in 10^6 per year. The TCXO eliminates the need for an external 5 MHz source to drive the synthesizer. The oscillator is a non-repairable assembly (Fluke part number 362798) which mounts in the rear portion of the unit. DC power and the 5 MHz output connections are all made to terminals on the Mother Board PCB Assembly, A13.

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the

Lists of Replaceable parts contained in Section 5. The following information is presented in this section:

TABLE	TITLE	PAGE
7-1.	List of Abbreviations	7-2
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7-3.	Fluke Technical Service Centers	7-7
7-4.	International Service Centers	7-7
7-5.	Sales Representatives-Domestic	7-8
7-6.	Sales Representatives-International	7-9

Table 7-1. LIST OF ABBREVIATIONS AND SYMBOLS

A or amp	ampere	H	henry	pF	picofarad
ac	alternating current	hd	heavy duty	pn	part number
af	audio frequency	hf	high frequency	(+) or pos	positive
a/d	analog-to-digital	Hz	hertz	pot	potentiometer
assy	assembly	IC	integrated circuit	p-p	peak-to-peak
AWG	american wire gauge	if	intermediate frequency	ppm	parts per million
B	bel	in	inch(es)	PROM	programmable read-only memory
bcd	binary coded decimal	intl	internal	psi	pound-force per square inch
°C	Celsius	I/O	input/output	RAM	random-access memory
cap	capacitor	k	kilo (10^3)	rf	radio frequency
ccw	counterclockwise	kHz	kilohertz	rms	root mean square
cer	ceramic	k Ω	kilohm(s)	ROM	read-only memory
cermet	ceramic to metal(seal)	kV	kilovolt(s)	s or sec	second (time)
ckt	circuit	lf	low frequency	scope	oscilloscope
cm	centimeter	LED	light-emitting diode	SH	shield
cmrr	common mode rejection ratio	LSB	least significant bit	Si	silicon
comp	composition	LSD	least significant digit	serno	serial number
cont	continue	M	mega (10^6)	sr	shift register
crt	cathode-ray tube	m	milli (10^{-3})	Ta	tantalum
cw	clockwise	mA	milliamperes(s)	tb	terminal board
d/a	digital-to-analog	max	maximum	tc	temperature coefficient or temperature compensating
dac	digital-to-analog converter	mf	metal film	tcxo	temperature compensated crystal oscillator
dB	decibel	MHz	megahertz	tp	test point
dc	direct current	min	minimum	u or μ	micro (10^{-6})
dmm	digital multimeter	mm	millimeter	uhf	ultra high frequency
dvm	digital voltmeter	ms	millisecond	us or μ s	microsecond(s) (10^{-6})
elect	electrolytic	MSB	most significant bit	uut	unit under test
ext	external	MSD	most significant digit	V	volt
F	farad	MTBF	mean time between failures	v	voltage
°F	Fahrenheit	MTTR	mean time to repair	var	variable
FET	Field-effect transistor	mV	millivolt(s)	vco	voltage controlled oscillator
ff	flip-flop	mv	multivibrator	vhf	very high frequency
freq	frequency	M Ω	megohm(s)	vlf	very low frequency
FSN	federal stock number	n	nano (10^{-9})	W	watt(s)
g	gram	na	not applicable	ww	wire wound
G	giga (10^9)	NC	normally closed	xfmr	transformer
gd	guard	(-) or neg	negative	xstr	transistor
Ge	germanium	NO	normally open	xtal	crystal
GHz	gigahertz	ns	nanosecond	xtlo	crystal oscillator
gmV	guaranteed minimum value	opnl ampl	operational amplifier	Ω	ohm(s)
gnd	ground	p	pico (10^{-12})	μ	micro (10^{-6})
		para	paragraph		
		pcb	printed circuit board		

Table 7-2. FEDERAL SUPPLY CODES FOR MANUFACTURERS

00213 Nytronics Comp. Group Inc. Subsidiary of Nytronics Inc. Formerly Sage Electronics Rochester, New York	03787 Eidema Div. Genisco Technology Corp. Compton, California	05574 Viking Industries Chatsworth, California	07597 Burndy Corp. Tape/Cable Div. Rochester, New York
00327 Welwyn International, Inc. Westlake, Ohio	03877 Transistron Electronic Corp. Wakefield, Massachusetts	05704 Replaced by 16258	07792 Lerma Engineering Corp. Northampton, Massachusetts
00656 Aerovox Corp. New Bedford, Massachusetts	03888 KDI Pyrofilm Corp. Whippany, New Jersey	05820 Wakefield Engineering Inc. Wakefield, Massachusetts	07910 Teledyne Semiconductor Formerly Continental Device Hawthorne, California
00686 Film Capacitors, Inc. Passaic, New Jersey	03911 Clairex Electronics Div. Clairex Corp. Mt. Vernon, New York	06001 General Electric Co. Electronic Capacitor & Battery Products Dept. Columbia, South Carolina	07933 - use 49956 Raytheon Co. Semiconductor Div. HQ Mountain View, California
00779 AMP Inc. Harrisburg, Pennsylvania	03980 Muirhead Inc. Mountainside, New Jersey	06136 Replaced by 63743	08225 Industro Transistor Corp. Long Island City, New York
01121 Alien-Bradley Co. Milwaukee, Wisconsin	04009 Arrow Hart Inc. Hartford, Connecticut	06383 Panduit Corp. Tinley Park, Illinois	08261 Spectra Strip Corp. Garden Grove, California
01281 TRW Electronic Comp. Semiconductor Operations Lawndale, California	04062 Replaced by 72136	06473 Bunker Ramo Corp. Amphenol SAMS Div. Chatsworth, California	08530 Reliance Mica Corp. Brooklyn, New York
01295 Texas Instruments, Inc. Semiconductor Group Dallas, Texas	04202 Replaced by 81312	06555 Beede Electrical Instrument Co. Penacook, New Hampshire	08806 General Electric Co. Miniature Lamp Products Dept. Cleveland, Ohio
01537 Motorola Communications & Electronics Inc. Franklin Park, Illinois	04217 Essex International Inc. Wire & Cable Div. Anaheim, California	06739 Electron Corp. Littleton, Colorado	08863 Nylomatic Corp. Norrisville, Pennsylvania
01686 RCL Electronics Inc. Manchester, New Hampshire	04221 Aemco, Div. of Midtex Inc. Mankato, Minnesota	06743 Clevite Corp. Cleveland, Ohio	08988 - use 53085 Skottie Electronics Inc. Archbold, Pennsylvania
01730 Replaced by 73586	04222 AVX Ceramics Div. AVX Corp. Myrtle Beach, Florida	06751 Components, Inc. Semcor Div. Phoenix, Arizona	09214 G.E. Co. Semi-Conductor Products Dept. Power Semi-Conductor Products OPN Sec. Auburn, New York
01884 - use 56289 Sprague Electric Co. Dearborn Electronic Div. Lockwood, Florida	04423 Telonic Industries Laguna Beach, California	06860 Gould Automotive Div. City of Industry, California	09353 C and K Components Watertown, Massachusetts
02114 Ferrocube Corp. Saugerties, New York	04645 Replaced by 75376	06961 Vernitron Corp., Piezo Electric Div. Formerly Clevite Corp., Piezo Electric Div. Bedford, Ohio	09423 Scientific Components, Inc. Santa Barbara, California
02131 General Instrument Corp. Harris ASW Div. Westwood, Maine	04713 Motorola Inc. Semiconductor Products Phoenix, Arizona	06980 Eimac Div. Varian Associates San Carlos, California	09922 Burndy Corp. Norwalk, Connecticut
02395 Rason Mfg. Co. Brooklyn, New York	04946 Standard Wire & Cable Los Angeles, California	07047 Ross Milton, Co., The South Hampton, Pennsylvania	09969 Dale Electronics Inc. Yankton, S. Dakota
02533 Snellgrove, C.R. Co., Ltd. Don Mills, Ontario, Canada M3B 1M2	05082 Replaced by 94988	07115 Replaced by 14674	10059 Barker Engineering Corp. Formerly Amerace, Amerace ESNA Corp. Kenilworth, New Jersey
02606 Fenwal Labs Div. of Travenol Labs. Morton Grove, Illinois	05236 Jonathan Mfg. Co. Fullerton, California	07138 Westinghouse Electric Corp., Electronic Tube Division Horsehead, New York	11236 CTS of Berne Berne, Indiana
02660 Bunker Ramo Corp., Conn Div. Formerly Amphenol-Borg Electric Corp. Broadview, Illinois	05245 Components Corp. now Corcom, Inc. Chicago, Illinois	07233 TRW Electronic Components Cinch Graphic City of Industry, California	11237 CTS Keene Inc. Paso Robles, California
02799 Aero Capacitors, Inc. Chatsworth, California	05277 Westinghouse Electric Corp. Semiconductor Div. Youngwood, Pennsylvania	07256 Silicon Transistor Corp. Div. of BBF Group Inc. Chelmsford, MA	11358 CBS Electronic Div. Columbia Broadcasting System Newburyport, MN
03508 General Electric Co. Semiconductor Products Syracuse, New York	05278 Replaced by 43543	07261 Aumet Corp. Culver City, California	11403 Best Products Co. Chicago, Illinois
03614 Replaced by 71400	05279 Southwest Machine & Plastic Co. Glendora, California	07263 Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California	11503 Keystone Columbia Inc. Warren, Michigan
03651 Replaced by 44655	05397 Union Carbide Corp. Materials Systems Div. New York, New York	07344 Bircher Co., Inc. Rochester, New York	11532 Teledyne Relays Hawthorne, California
	05571 - use 56289 Sprague Electric Co. Pacific Div. Los Angeles, California		

Table 7-2. FEDERAL SUPPLY CODES FOR MANUFACTURERS (Continued)

11711 General Instrument Corp. Rectifier Division Hickville, New York	14099 Semtech Corp. Newbury Park, California	17069 Circuit Structures Lab. Burbank, California	24655 General Radio Concord, Massachusetts
11726 Qualidyne Corp. Santa Clara, California	14140 Edison Electronic Div. Mc Gray-Edison Co. Manchester, New Hampshire	17338 High Pressure Eng. Co., Inc. Oklahoma City, Oklahoma	24759 Lenox-Fugle Electronics Inc. South Plainfield, New Jersey
12014 Chicago Rivet & Machine Co. Bellwood, Illinois	14193 Cal-R-Inc. formerly California Resistor, Corp. Santa Monica, California	17545 Atlantic Semiconductors, Inc. Asbury Park, New Jersey	25088 Siemen Corp. Isilon, New Jersey
12040 National Semiconductor Corp. Danbury, Connecticut	14298 American Components, Inc. an Insilco Co. Conshohocken, Pennsylvania	17856 Siliconix, Inc. Santa Clara, California	25403 Amperex Electronic Corp. Semiconductor & Micro-Circuits Div. Slatersville, Rhode Island
12060 Diodes, Inc. Chatsworth, California	14655 Cornell-Dublier Electronics Division of Federal Pacific Electric Co. Govt. Control Dept. Newark, New Jersey	17870 Replaced by 14140	27014 National Semiconductor Corp. Santa Clara, California
12136 Philadelphia Handle Co. Camden, New Jersey	14752 Electro Cube Inc. San Gabriel, California	18178 Vactec Inc. Maryland Heights, Missouri	27264 Molex Products Downers Grove, Illinois
12300 Potter-Brumfield Division AMF Canada LTD. Guelph, Ontario, Canada	14869 Replaced by 96853	18324 Signetics Corp. Sunnyvale, California	28213 Minnesota Mining & Mfg. Co. Consumer Products Div. St. Paul, Minnesota
12323 Presin Co., Inc. Shelton, Connecticut	14936 General Instrument Corp. Semi Conductor Products Group Hicksville, New York	18612 Vishay Resistor Products Div. Vishay Intertechnology Inc. Malvern, Pennsylvania	28425 Serv.-Link formerly Bohannon Industries Fort Worth, Texas
12327 Freeway Corp. formerly Freeway Washer & Stamping Co. Cleveland, Ohio	15636 Elec-Trol Inc. Saugus, California	18736 Voltronics Corp. Hanover, New Jersey	28478 Deltrol Controls Div. Deltrol Corporation Milwaukee, Wisconsin
12443 Budd Co. The, Polychem Products Plastic Products Div. Bridgeport, PA	15801 Fenwal Electronics Inc. Div. of Kidde Walter and Co., Inc. Framingham, Massachusetts	18927 G T E Sylvania Inc. Precision Material Group Parts Division Titusville, Pennsylvania	28480 Hewlett Packard Co. Corporate H.O. Palo Alto, California
12615 U.S. Terminals Inc. Cincinnati, Ohio	15818 Teledyne Semiconductors, formerly Amelco Semiconductor Mountain View, California	19451 Perine Machinery & Supply Co. Seattle, Washington	28520 Heyman Mfg. Co. Kenilworth, New Jersey
12617 Hamlin Inc. Lake Mills, Wisconsin	15849 Litton Systems Inc. Uscco Div. formerly Uscco Inc. Van Nuys, California	19701 Electro-Midland Corp. Mopco-Electra Inc. Mineral Wells, Texas	29083 Monsanto, Co., Inc. Santa Clara, California
12697 ClaroStat Mfg. Co. Dover, New Hampshire	15898 International Business Machines Corp. Essex Junction, Vermont	20584 Enochs Mfg. Inc. Indianapolis, Indiana	29604 Stackpole Components Co. Raleigh, North Carolina
12749 James Electronics Chicago, Illinois	15909 Replaced by 14140	20891 Self-Organizing Systems, Inc. Dallas, Texas	30148 A B Enterprise Inc. Ahoskie, North Carolina
12856 Micrometals Sierra Madre, California	16258 Space-Lok Inc. Burbank, California	21604 Buckeye Stamping Co. Columbus, Ohio	30323 Illinois Tool Works, Inc. Chicago, Illinois
12954 Dickson Electronics Corp. Scottsdale, Arizona	16299 Corning Glass Electronic Components Div. Raleigh, North Carolina	21845 Solitron Devices Inc. Transistor Division Riviera Beach, Florida	31091 Optimax Inc. Colmar, Pennsylvania
12969 Unitrode Corp. Watertown, Massachusetts	16332 Replaced by 28478	22767 ITT Semiconductors Palo Alto, California	32539 Mura Corp. Great Neck, New York
13103 Thermalloy Co., Inc. Dallas, Texas	16473 Cambridge Scientific Ind. Div. of Chemed Corporation Cambridge, Maryland	23050 Product Comp. Corp. Mount Vernon, New York	32767 Griffith Plastic Corp. Burlingame, California
13327 Solitron Devices Inc. Tappan, New York	16742 Paramount Plastics Fabricators, Inc. Downey, California	23732 Tracor Inc. Rockville, Maryland	32879 Advanced Mechanical Components Northridge, California
13511 Amphenol Cadre Div. Bunker-Ramo Corp. Los Gatos, California	16758 Delco Electronics Div. of General Motors Corp. Kokomo, Indiana	23880 Stanford Applied Engrng. Santa Clara, California	32897 Eric Technological Products, Inc. Frequency Control Div. Carlisle, Pennsylvania
13606 - use 56289 Sprague Electric Co. Transistor Div. Concord, New Hampshire	17001 Replaced by 71468	23936 Pamotor Div., Wm. J. Purdy Co. Burlingame, California	32997 Bourns Inc. Trimpot Products Division Riverside, California
13839 Replaced by 23732		24248 Replaced by 94222	33173 General Electric Co. Products Dept. Owensboro, Kentucky
		24355 Analog Devices Inc. Norwood, Massachusetts	

Table 7-2. FEDERAL SUPPLY CODES FOR MANUFACTURERS (Continued)

34333 Silicon General Westminster, California	70563 Amperite Company Union City, New Jersey	73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, California	77969 Rubbercraft Corp. of CA. LTD. Torrance, California
34335 Advanced Micro Devices Sunnyvale, California	70903 Belden Corp. Geneva, Illinois	7344 ⁺ Amperex Electronic Corp. Hicksville, LI, New York	78189 Shakeproof Div. of Illinois Tool Works Inc. Elgin, Illinois
34802 Electromotive Inc. Kenilworth, New Jersey	71002 Birnback Radio Co., Inc. Freeport, LI New York	73559 Carling Electric Inc. West Hartford, Connecticut	78277 Sigma Instruments, Inc. South Braintree, Massachusetts
37942 Mallory, P.R. & Co., Inc. Indianapolis, Indiana	71400 Bussmann Mfg. Div. of McGraw-Edison Co. Saint Louis, Missouri	73586 Circle F Industries Trenton, New Jersey	78488 Stackpole Carbon Co. Saint Marys, Pennsylvania
42498 National Radio Melrose, Massachusetts	71450 CTS Corp. Elkhart, Indiana	73734 Federal Screw Products, Inc. Chicago, Illinois	78553 Eaton Corp. Engineered Fastener Div. Tinnerman Plant Cleveland, Ohio
43543 Nytronics Inc. Transformer Co. Div. Geneva, New York	71468 ITT Cannon Electric Inc. Santa Ana, California	73743 Fischer Special Mfg. Co. Cincinnati, Ohio	79136 Waldes Kohinoor Inc. Long Island City, New York
44655 Ohmite Mfg. Co. Skokie, Illinois	71482 Clare, C.P. & Co. Chicago, Illinois	73899 JFD Electronics Co. Components Corp Brooklyn, New York	79497 Western Rubber Company Goshen, Indiana
46...1 RCA Corp. New York, New York	71590 Centrelab Electronics Div. of Globe Union Inc. Milwaukee, Wisconsin	73949 Guardian Electric Mfg. Co. Chicago, Illinois	79963 Zierick Mfg. Corp. Mt. Kisco, New York
49956 Raytheon Company Lexington, Massachusetts	71707 Coto Coil Co., Inc. Providence, Rhode Island	74199 Quan Nichols Co. Chicago, Illinois	80031 Electro-Midland Corp., Mecco Div. A North American Phillips Co. Morristown, New Jersey
50088 Mostek Corp. Carrollton, Texas	71744 Chicago Miniature Lamp Works Chicago, Illinois	74217 Radio Switch Corp. Marlboro, New Jersey	80145 LFE Corp., Process Control Div. formerly API Instrument Co. Chesterland, Ohio
50579 Litronix Inc. Cupertino, California	71785 TRW Electronics Components Cinch Connector Operations Div. Elk Grove Village, Chicago, Illinois	74276 Signalite Div. General Instrument Corp. Neptune, New Jersey	80183 - use 56289 Sprague Products North Adams, Massachusetts
51805 Scientific Components Inc. Linden, New Jersey	72005 Driver, Wilber B., Co. Newark, New Jersey	74306 Piezo Crystal Co. Carlisle, Pennsylvania	80294 Bourns Inc., Instrument Div. Riverside, California
53021 Sangamo Electric Co. Springfield, Illinois	72092 Replaced by 06980	74542 Hoyt Elect. Instr. Works Penacook, New Hampshire	80583 Hammarlund Mfg. Co., Inc. Red Bank, New Jersey
54294 Cutler-Hammer Inc. formerly Shallcross, A Cutter-Hammer Co. Selma, North Carolina	72136 Electro Motive Mfg. Co. Williamantic, Connecticut	74970 Johnson E.F., Co. Waseca, Minnesota	80640 Stevens, Arnold Inc. South Boston, Massachusetts
55026 Simpson Electric Co. Div. of Am. Gage and Mach. Co. Elgin, Illinois	72259 Nytronics Inc. Pelham Manor, New Jersey	75042 TRW Electronics Components IAC Fixed Resistors Philadelphia, Pennsylvania	81073 Grayhill, Inc. La Grange, Illinois
56289 Sprague Electric Co. North Adams, Massachusetts	72619 Dialight Div. Amperex Electronic Corp. Brooklyn, New York	75376 Kurz-Kasch Inc. Dayton, Ohio	81312 Winchester Electronics Div. of Litton Industries Inc. Oakville, Connecticut
58474 Superior Electric Co. Bristol, Connecticut	72653 G.C. Electronics Div. of Hydrometals, Inc. Brooklyn, New York	75378 CTS Knights Inc. Sandwich, Illinois	81439 Therm-O-Disc Inc. Mansfield, Ohio
60399 Torin Corp. formerly Torrington Mfg. Co. Torrington, Connecticut	72665 Replaced by 90303	75382 Kulka Electric Corp. Mount Vernon, New York	81483 International Rectifier Corp. Los Angeles, California
63743 Ward Leonard Electric Co., Inc. Mount Vernon, New York	72794 Dzus Fastener Co., Inc. West Islip, New York	75915 Littlefuse Inc. Des Plaines, Illinois	81590 Korry Mfg. Co. Seattle, Washington
64834 West Mfg. Co. San Francisco, California	72928 Gulton Ind. Inc. Gudeman Div. Chicago, Illinois	76854 Oak Industries Inc. Switch Div. Crystal Lake, Illinois	81741 Chicago Lock Co. Chicago, Illinois
65092 Weston Instruments Inc. Newark, New Jersey	72982 Erie Tech. Products Inc. Erie, Pennsylvania	77342 AMF Inc. Porter & Brumfield Div. Princeton, Indiana	82305 Palmer Electronics Corp. South Gate, California
66150 Winslow Tele-Tronics Inc. Eaton Town, New Jersey	73138 Beckman Instruments Inc. Helipot Division Fullerton, California	77638 General Instrument Corp. Rectifier Division Brooklyn, New York	82389 Switchcraft Inc. Chicago, Illinois
70485 Atlantic India Rubber Works Chicago, Illinois			

Table 7-2. FEDERAL SUPPLY CODES FOR MANUFACTURERS (Continued)

82415 North American Phillips Controls Corp. Frederick, Maryland	88245 Litton Systems Inc. Useco Div. Van Nuys, California	91934 Miller Electric Co., Inc. Div. of Aunet Woonsocket, Rhode Island	97966 Replaced by 11358
82872 Roanwell Corp. New York, New York	88419 Cornell-Dubilier Electronic Div. Federal Pacific Co. Fuquay-Varian, North Carolina	92194 Alpha Wire Corp. Elizabeth, New Jersey	98094 Replaced by 49956
82877 Rotron Inc. Woodstock, New York	88486 Plastic Wire & Cable Jewitt City, Connecticut	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, Massachusetts	98159 Rubber-Tech, Inc. Gardena, California
82879 ITT Royal Electric Div. Pawtucket, Rhode Island	88690 Replaced by 04217	94145 Replaced by 49956	98278 Malco A Microdot Co., Inc. Connector & Cable Div. Pasadena, California
83003 Varo Inc. Garland, Texas	89536 Fluke, John Mfg. Co., Inc. Seattle, Washington	94154 - use 94986 Wagner Electric Corp. Tung-Sol Div. Newark, New Jersey	98291 Sealectro Corp. Mamaroneck, New York
83058 Carr Co., The United Can Div. of TRW Cambridge, Massachusetts	89730 G.E. Co., Newark Lamp Works Newark, New Jersey	94227 Southco Inc. formerly South Chester Corp. Lester, Pennsylvania	98388 Royal Industries Products Div. San Diego, California
83298 Bendix Corp. Electric Power Division Eatontown, New Jersey	90201 Mallory Capacitor Co. Div. of P.R. Mallory Co., Inc. Indianapolis, Indiana	95146 Alco Electronic Products Inc. Lawrence, Massachusetts	98743 Replaced by 12749
83330 Smith, Herman H., Inc. Brooklyn, New York	90211 - use 56365 Square D Co. Chicago, Illinois	95263 Leecraft Mfg. Co. Long Island City, New York	98925 Replaced by 14433
83478 Rubbercraft Corp. of America, Inc. West Haven, Connecticut	90215 Best Stamp & Mfg. Co. Kansas City, Missouri	95264 Replaced by 98278	99120 Plastic Capacitors, Inc. Chicago, Illinois
83594 Burroughs Corp. Electronic Components Div. Plainfield, New Jersey	90303 Mallory Battery Co. Div. of Mallory Co., Inc. Tarrytown, New York	95275 Vitramon Inc. Bridgeport, Connecticut	99217 Bell Industries Elect. Comp. Div. formerly Southern Elect. Div. Burbank, California
83740 Union Carbide Corp. Battery Products Div. formerly Consumer Products Div. New York, New York	91094 Essex International Inc. Suglex/IWP Div. Newmarket, New Hampshire	95303 RCA Corp. Receiving Tube Div. Cincinnati, Ohio	99392 STM Oakland, California
84171 Arco Electronics Great Neck, New York	91293 Johanson Mfg. Co. Boonton, New Jersey	95348 Gordo's Corp. Bloomfield, New Jersey	99515 ITT Jennings Monrovia Plant Div. of ITT Jennings formerly Marshall Industries Capacitor Div. Monrovia, California
84111 TRW Electronic Components TRW Capacitors Ogallala, Nebraska	91407 Replaced by 58474	95354 Methode Mfg. Corp. Rolling Meadows, Illinois	99779 - use 29587 Bunker-Ramo Corp. Barnes Div. Landsdowne, Pennsylvania
84613 Fuse Indicator Corp. Rockville, Maryland	91502 Associated Machine Santa Clara, California	95712 Bendix Corp. Electrical Components Div. Microwave Devices Plant Franklin, Indiana	99800 American Precision Industries Inc. Delevan Division East Aurora, New York
84682 Essex International Inc. Industrial Wire Div. Peabody, Massachusetts	91506 Augat Inc. Attleboro, Massachusetts	95987 Weckesser Co. Inc. Chicago, Illinois	99942 Centrelab Semiconductor Centrelab Electronics Div. of Globe-Union Inc. El Monte, California
86577 Precision Metal Products, of Malden Inc. Stoneham, Massachusetts	91637 Dale Electronics Inc. Columbus, Nebraska	96733 San Fernando Electric Mfg. Co. San Fernando, California	Toy Electronics (R-Ohm Corp.) Irvine, California
86684 Radio Corp. of America Electronic Components Div. Harrison, New Jersey	91667 Elco Corp. Willow Grove, Pennsylvania	96853 Gulton Industries Inc. Measurement and Controls Div. formerly Rustek Instruments Co. Manchester, New Hampshire	National Connector Minneapolis, Minnesota
86928 Seastrom Mfg. Co., Inc. Glendale, California	91737 - use 71468 Gremar Mfg. Co., Inc. ITT Cannon/Gremar Santa Ana, California	96881 Thomson Industries, Inc. Manhasset, New York	
87034 Illuminated Products Inc. Subsidiary of Oak Industries Inc. Anaheim, California	91802 Industrial Devices, Inc. Edgewater, New Jersey	97540 Master Mobile Mounts Div. of Whitehall Electronics Corp. Ft. Meyers, Florida	
88219 Gould Inc. Industrial Div. Trenton, New Jersey	91833 Keystone Electronics Corp. New York, New York	97913 Industrial Electronic Hardware Corp. New York, New York	
	91836 King's Electronics Co., Inc. Tuckahoe, New York	97945 Penwalt Corp. SS White Industrial Products Div. Piscataway, New Jersey	
	91929 Honeywell Inc. Micro Switch Div. Freeport, Illinois		

Section 8

Schematic Diagrams

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8-18.	A18 Internal Frequency Standard PCB Assembly - Option 02	6160A-1018	8-25

FIG. 8-1
SHT. 1 OF 3

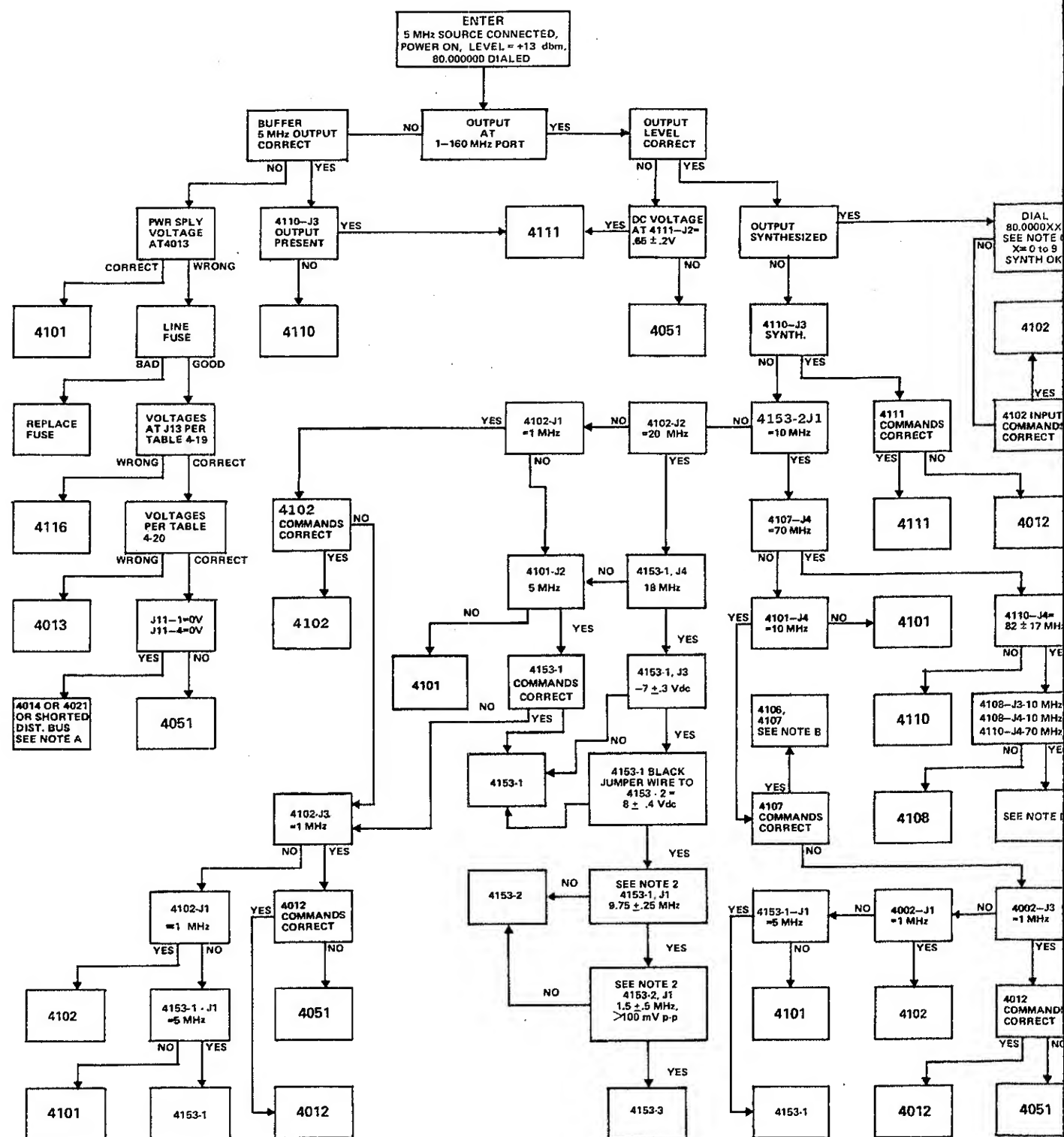
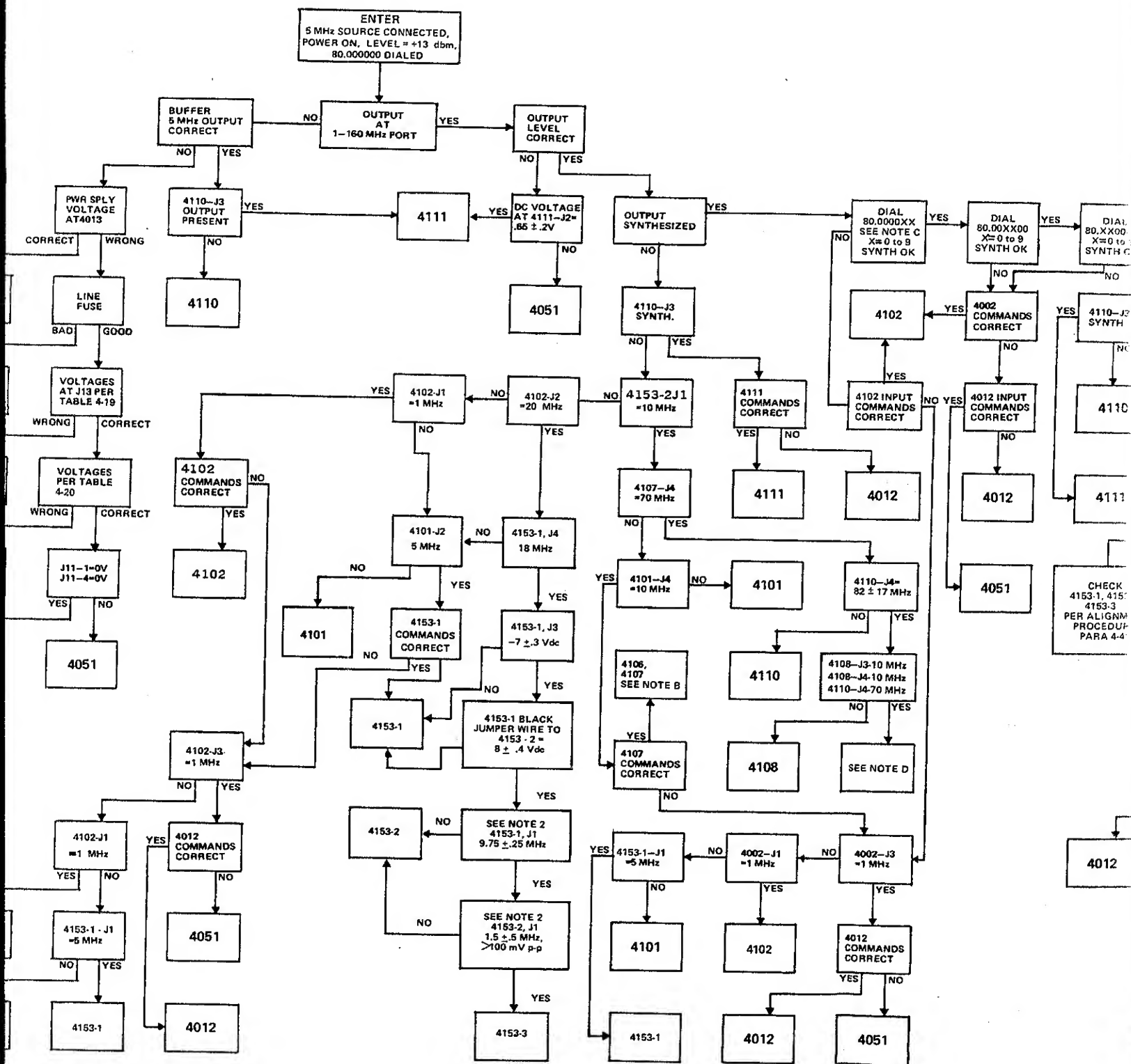
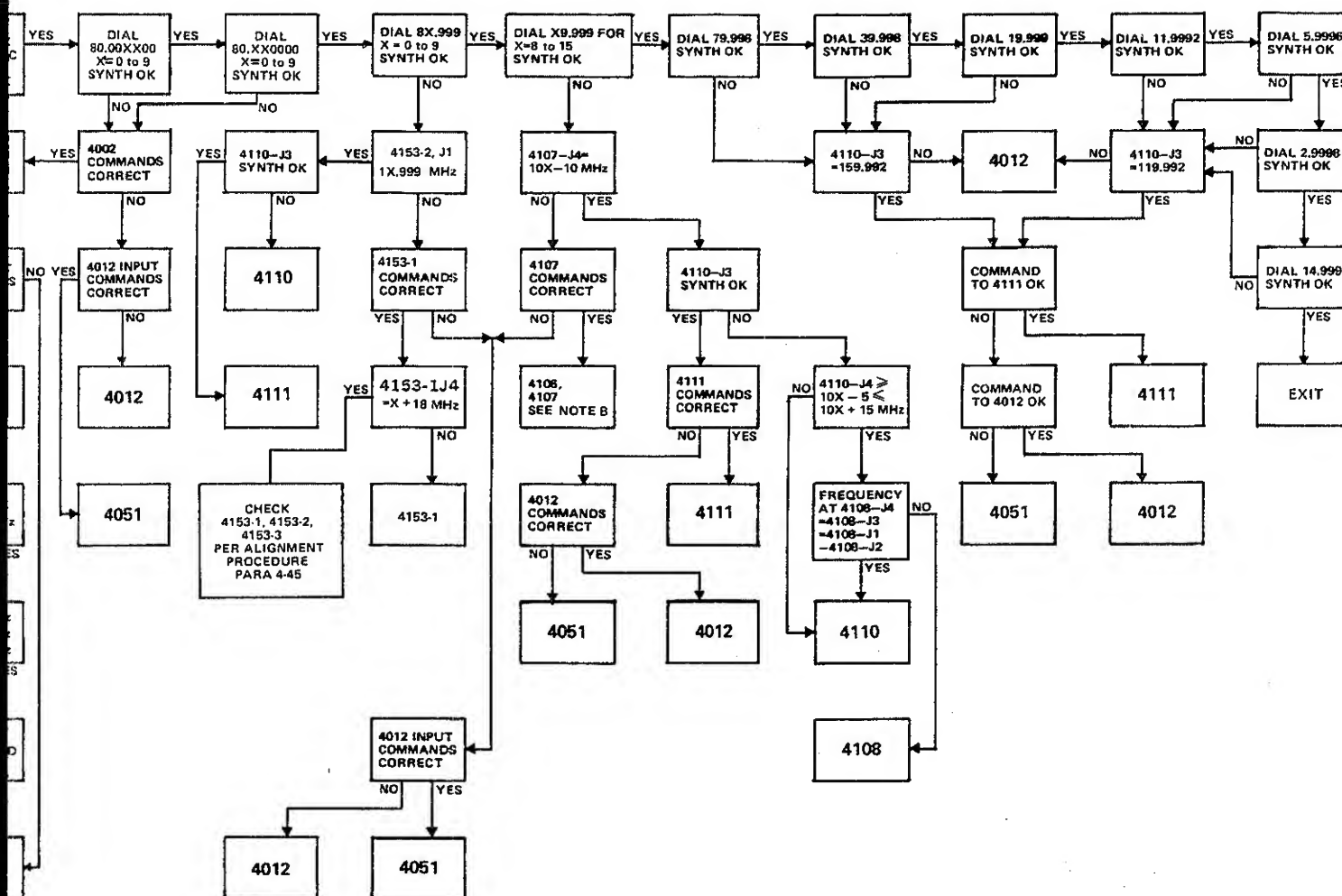


FIG. 8-1
SHT. 2 OF 3



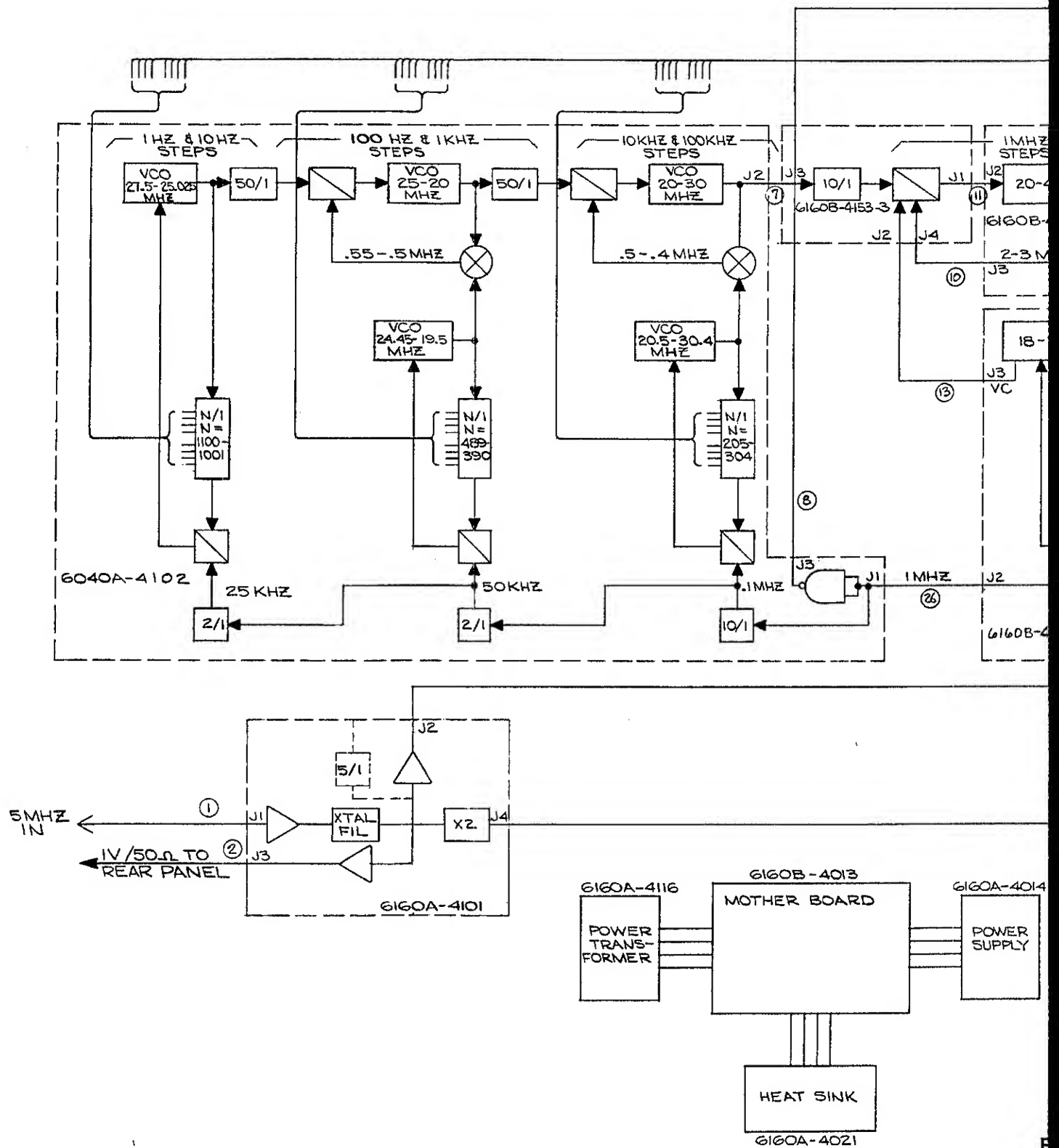


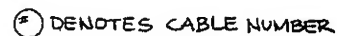
NOTES:

1. Alphabetical notes referenced in above blocks described in paragraph 4-85.
2. Connect J3 of 4153-1 to J2 of 4153-2.

FIGURE 8-1 MODEL 6160B TROUBLESHOOTING CHART (6160B-1600)

FIG. 8-2
SMT. 1 OF 2





8-4

FIG. 8-3
SHT. 1 OF 2

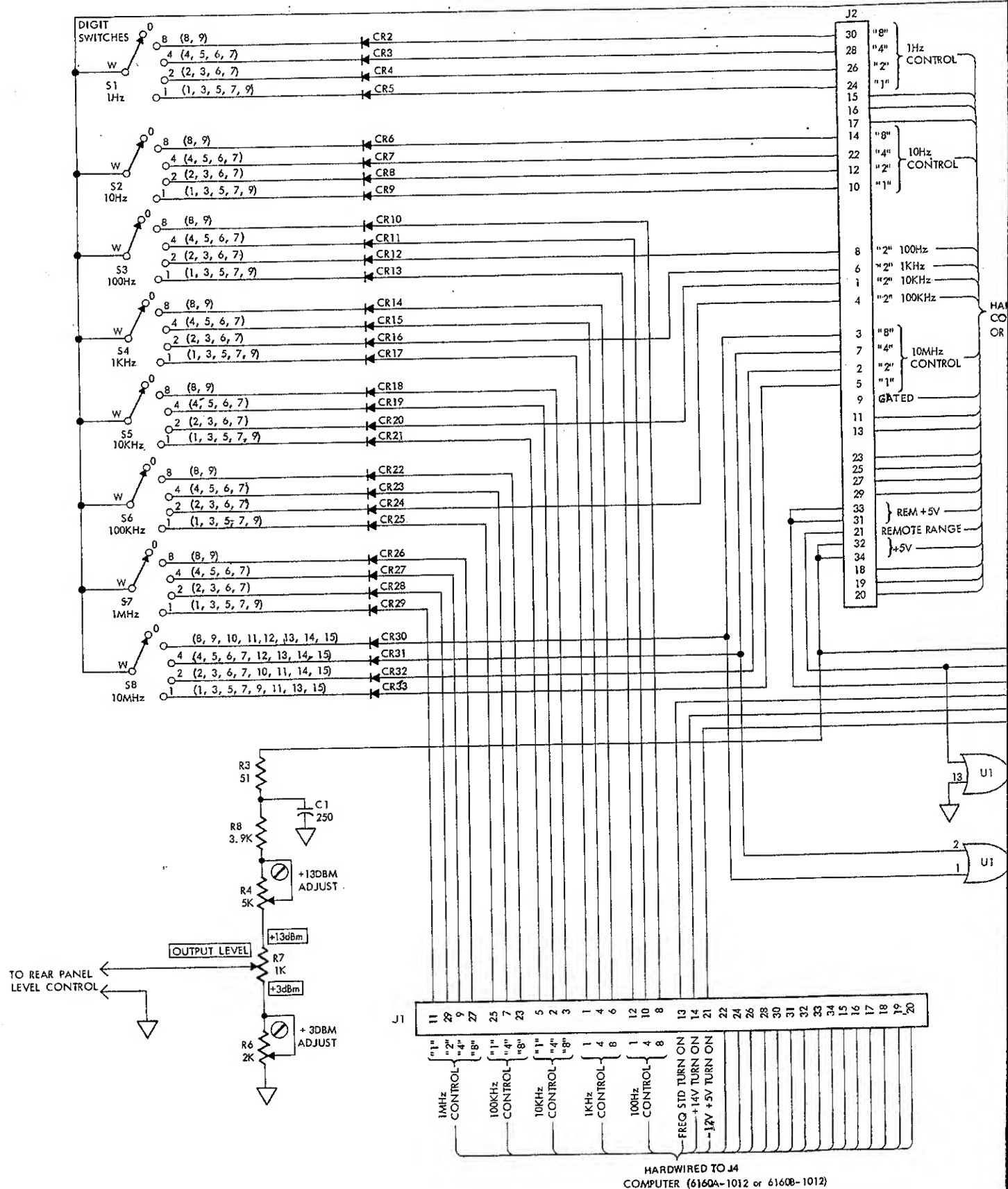


FIG. 8-3
SHT. 2 OF 2

6160B

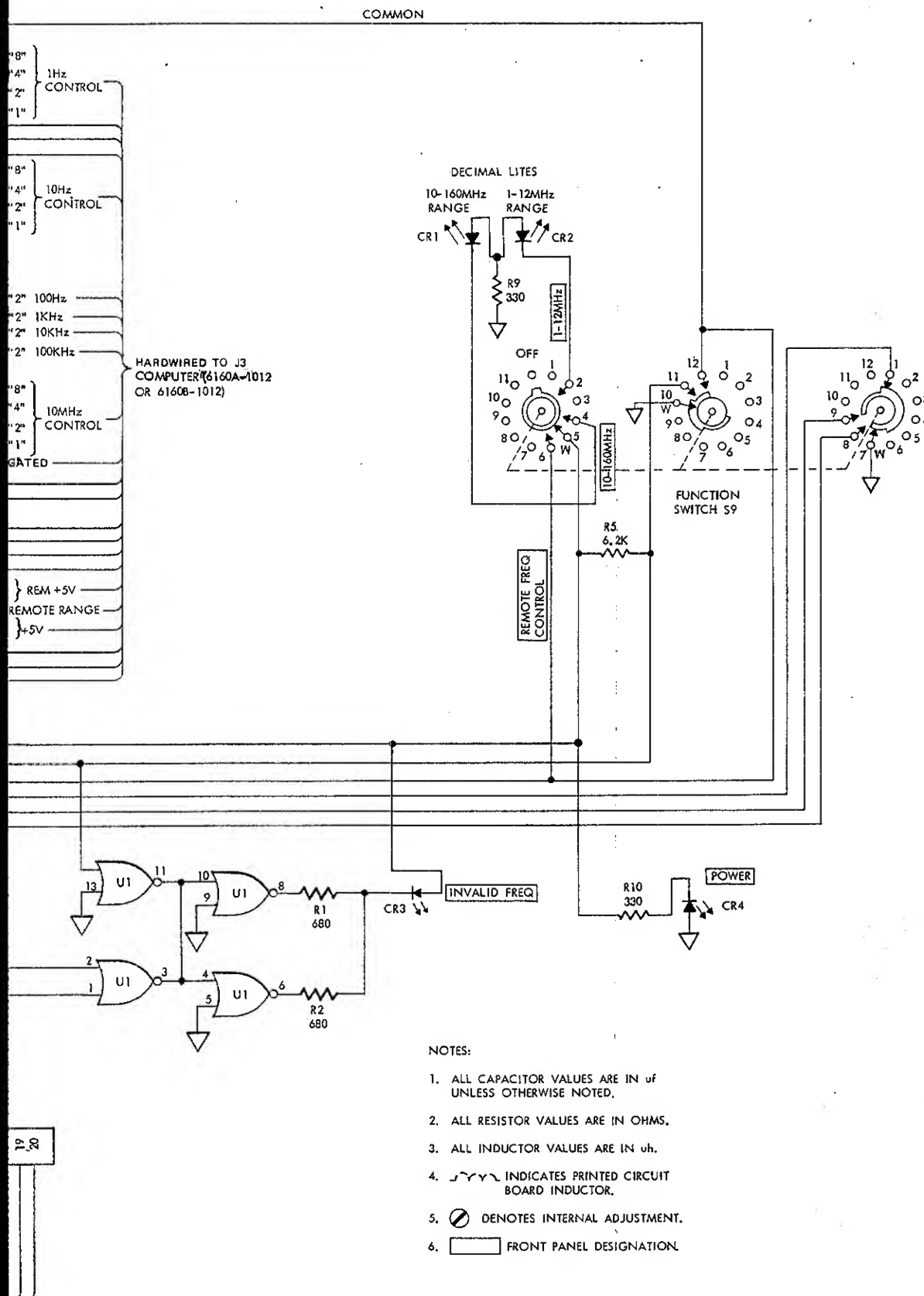
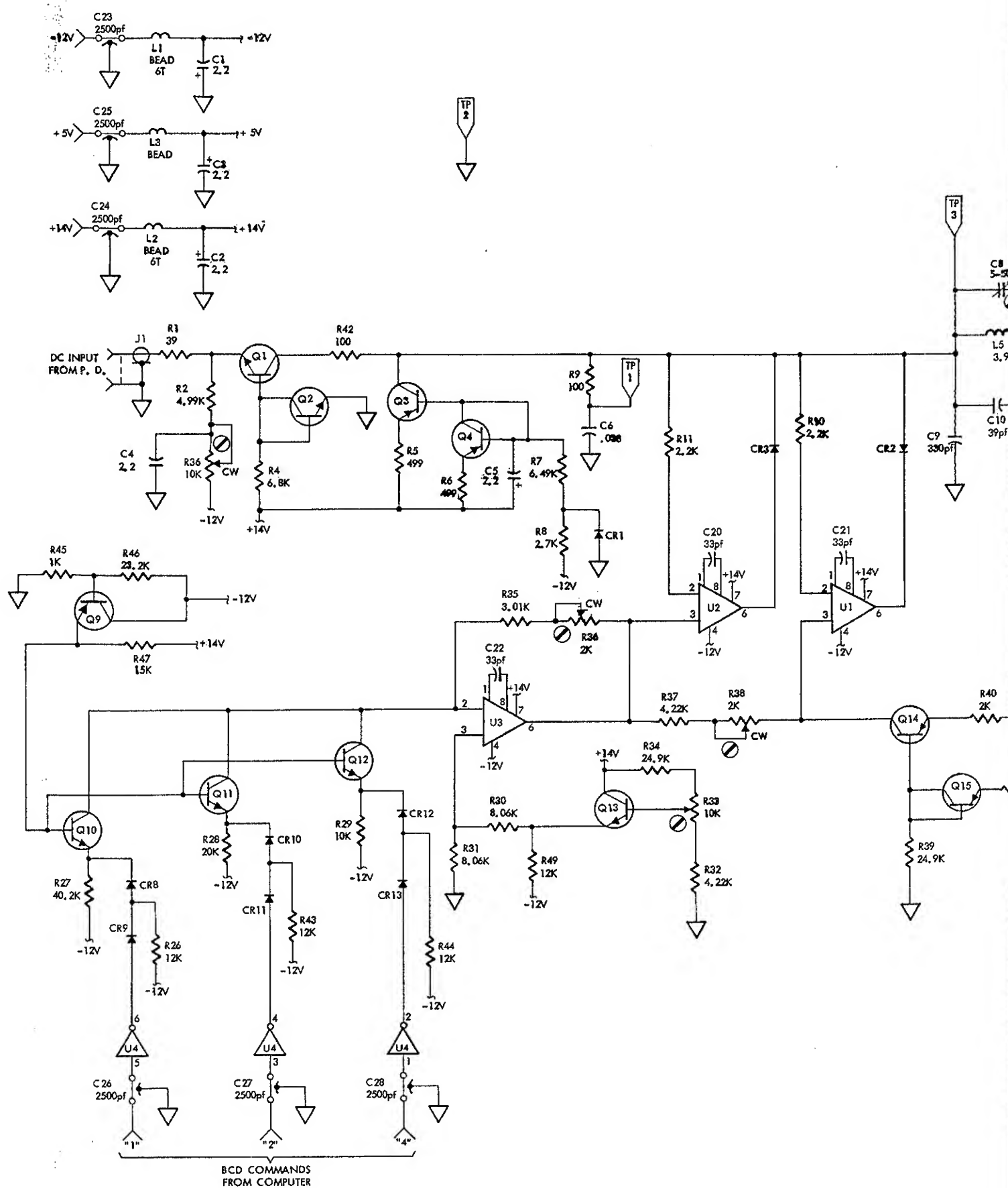


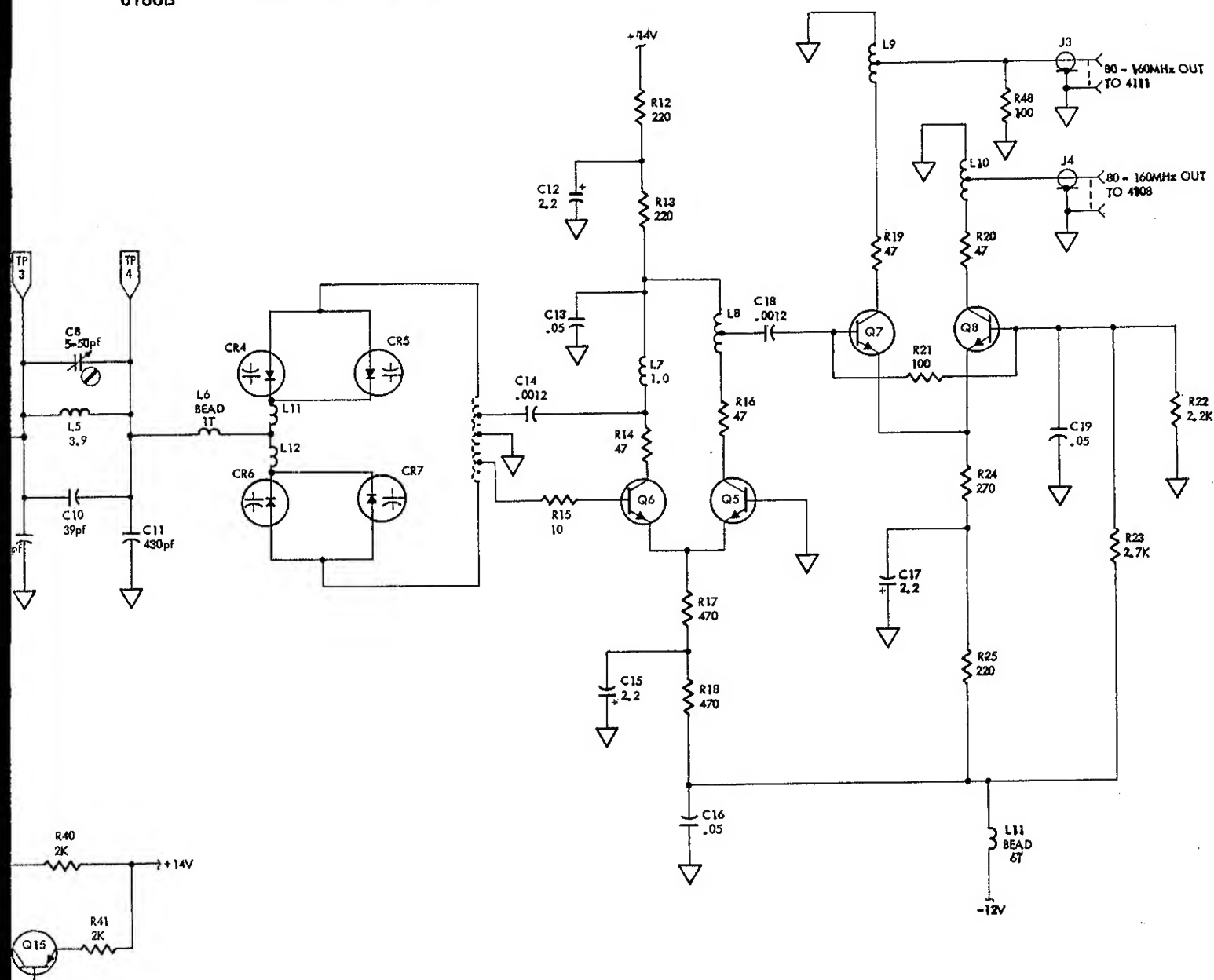
FIGURE 8-3 A1A1 FRONT PANEL PCB ASSEMBLY
(6160A-1051)

FIG. 8-4
SHT. 1 OF 2



6160B

FIG. 8-4
SHT. 2 OF 2



NOTES:



1. ALL CAPACITOR VALUES ARE IN μf UNLESS NOTED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OM OHMS.
3. ALL INDUCTOR VALUES ARE IN μh .
4.  INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5.  DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

FIGURE 8-4 A2A1 10 MHz MAIN LOOP VCO PCB ASSEMBLY (6160A-1010)

FIG. 8-5
SHT. 1 OF 3

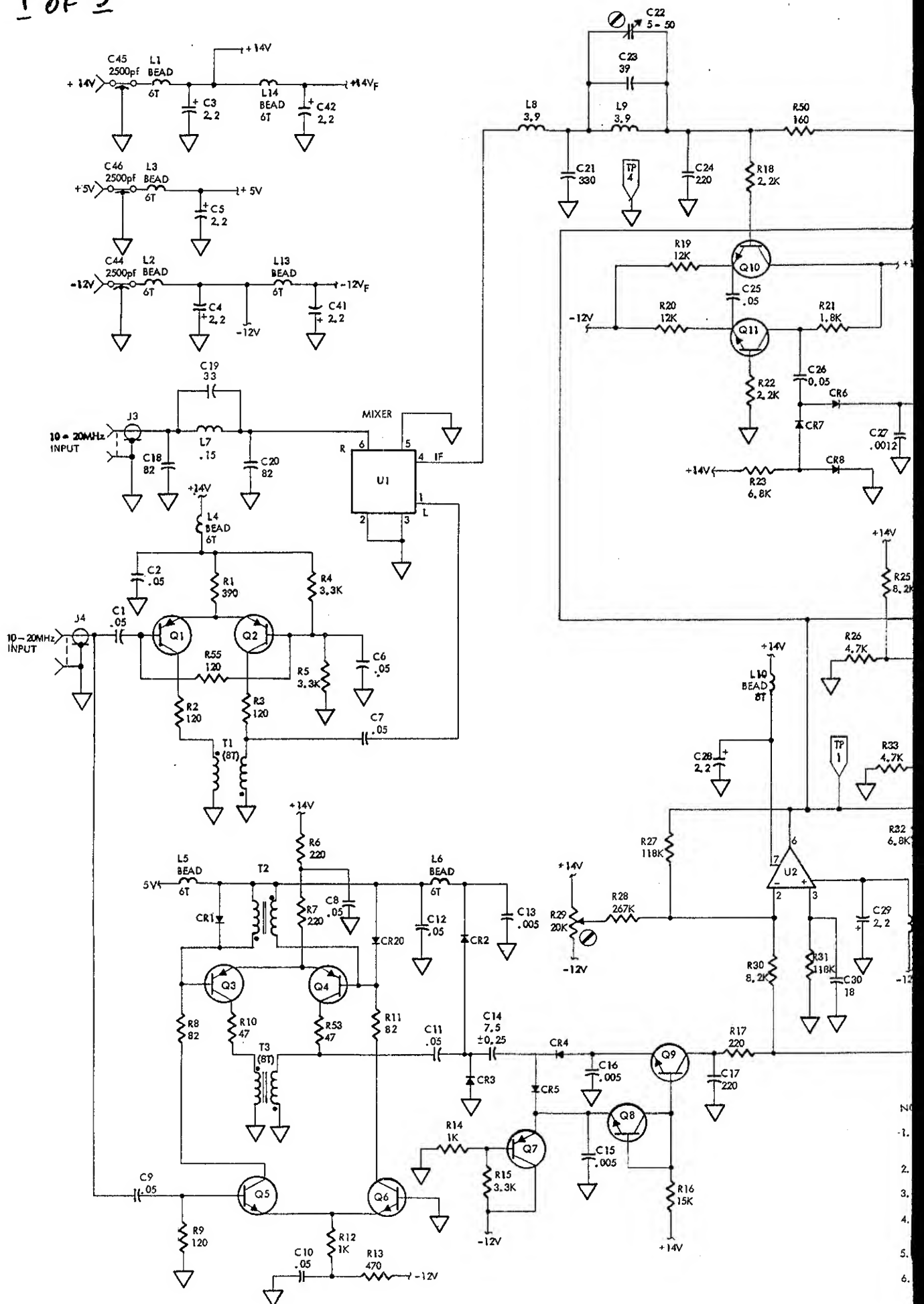


FIG. 8-5
SHT. 2 OF 3

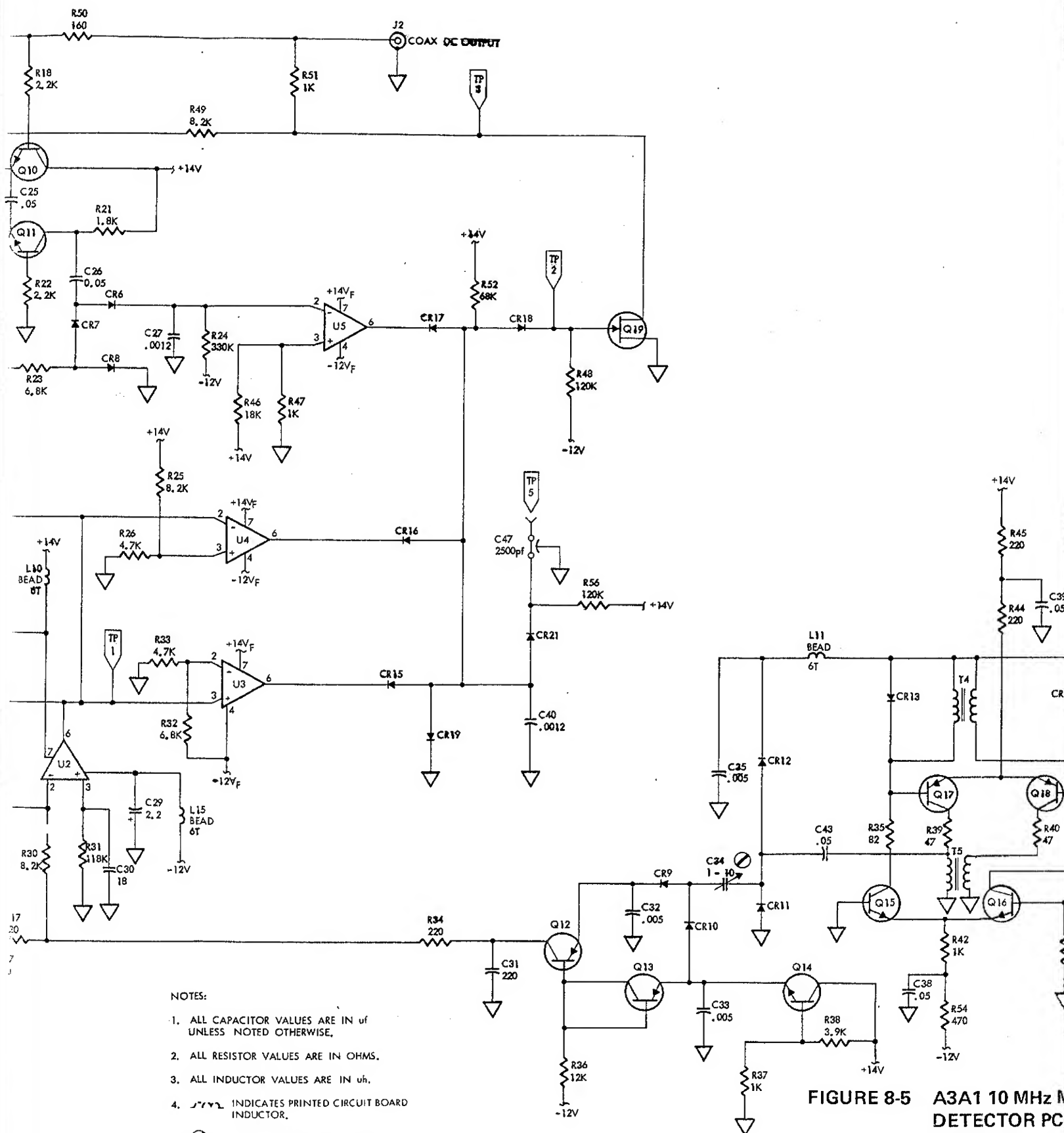


FIGURE 8-5 A3A1 10 MHz M
DETECTOR PCB
(6160A-1009)

FIG. 8-5
SHT. 3 OF 3

6160B

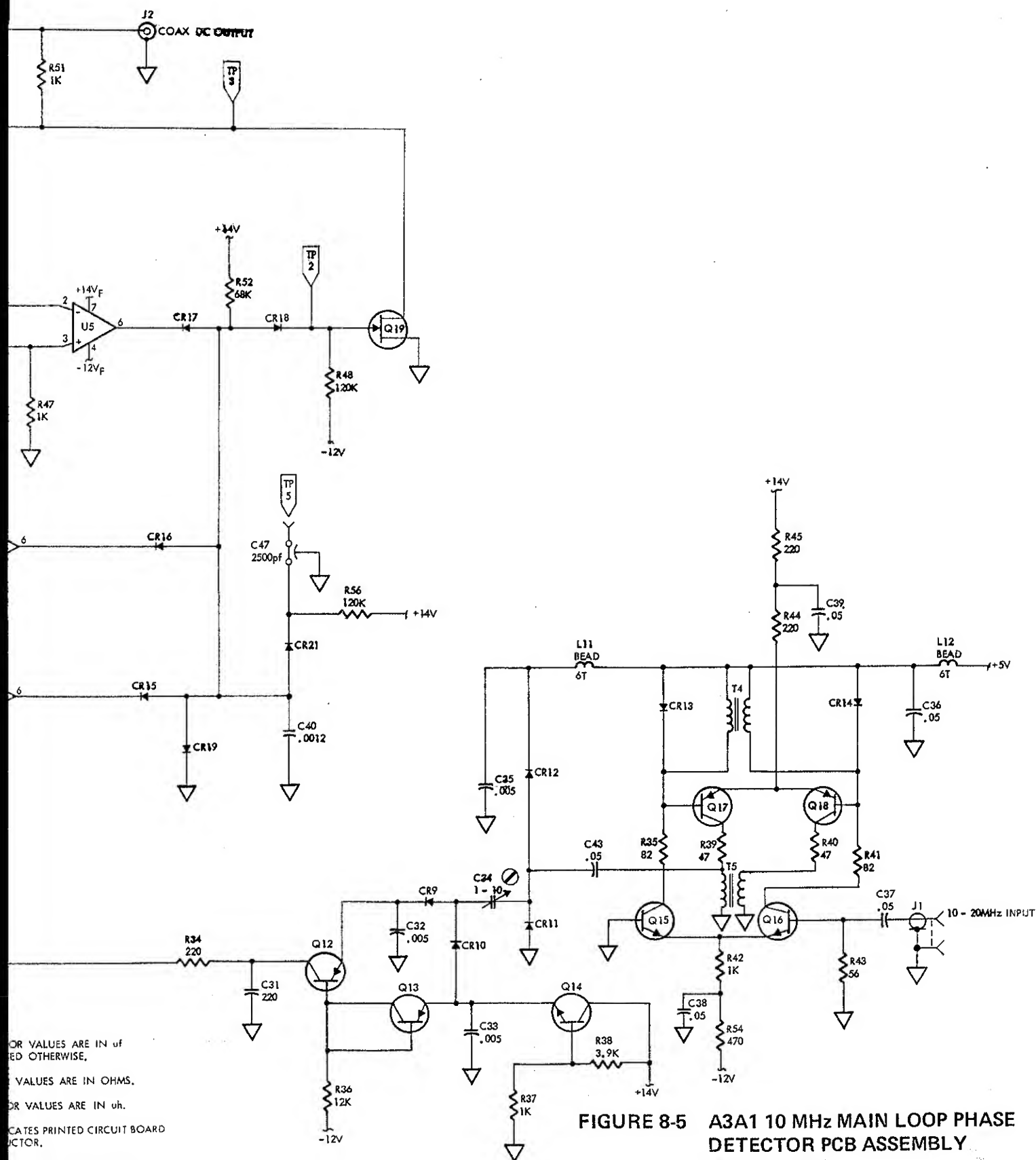
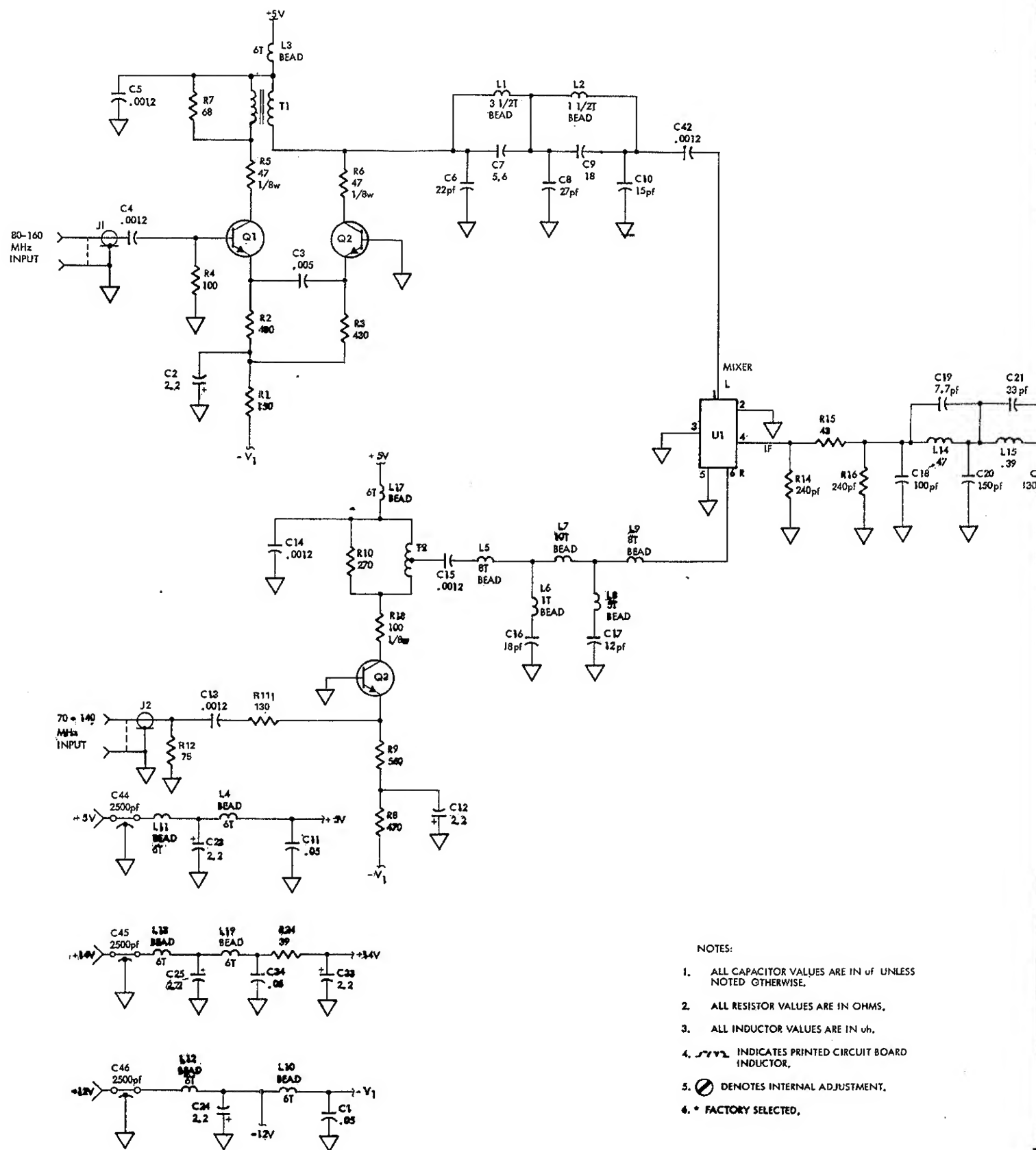


FIG. 8-6
SHT. 1 OF 2



NOTES:

1. ALL CAPACITOR VALUES ARE IN μ f UNLESS NOTED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN μ h.
4. INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

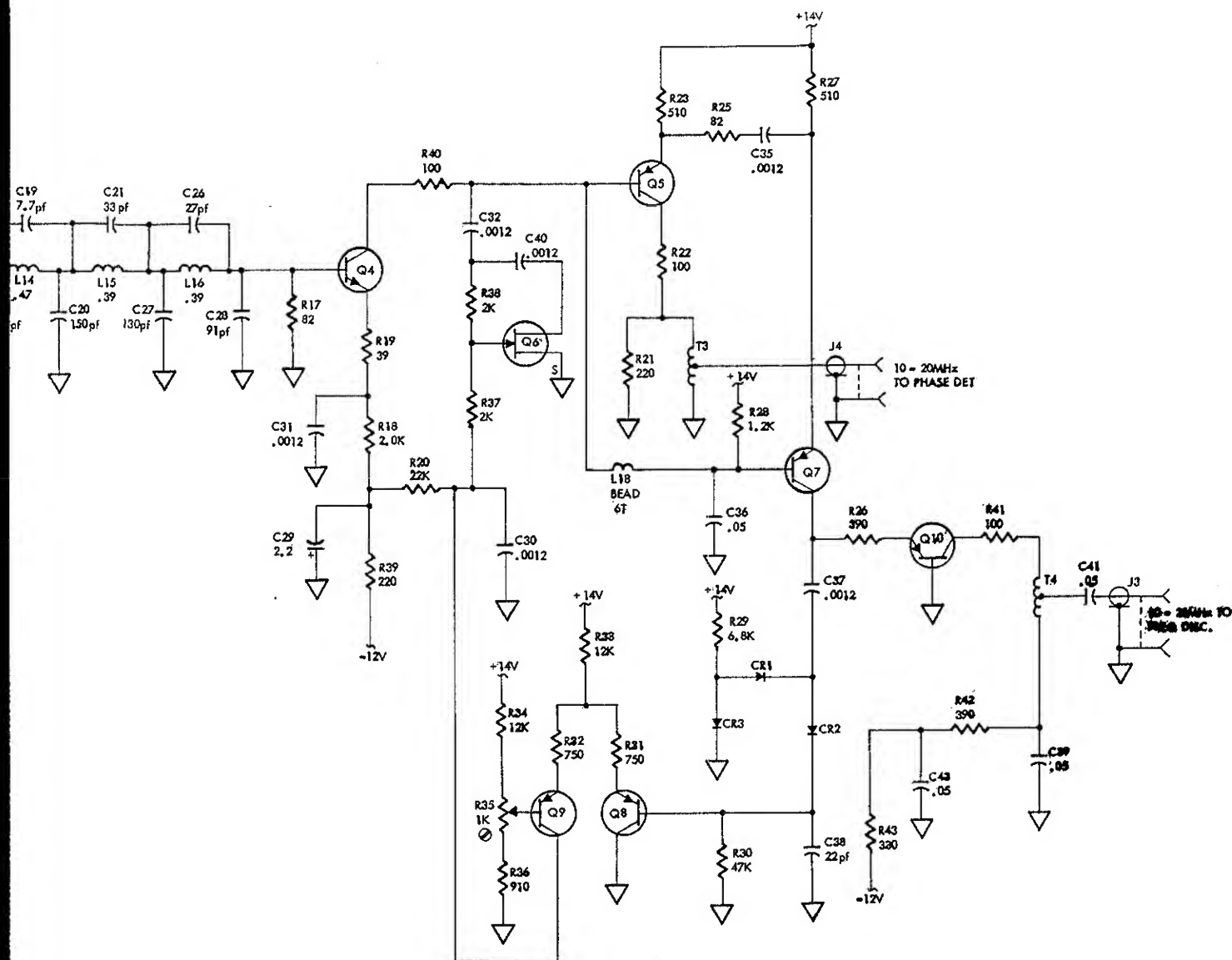


FIGURE 8-6 A4A1 10 MHz IF MIXER PCB ASSEMBLY
(6160A-1008)

FIG. 8-7
SHT. 1 OF 2

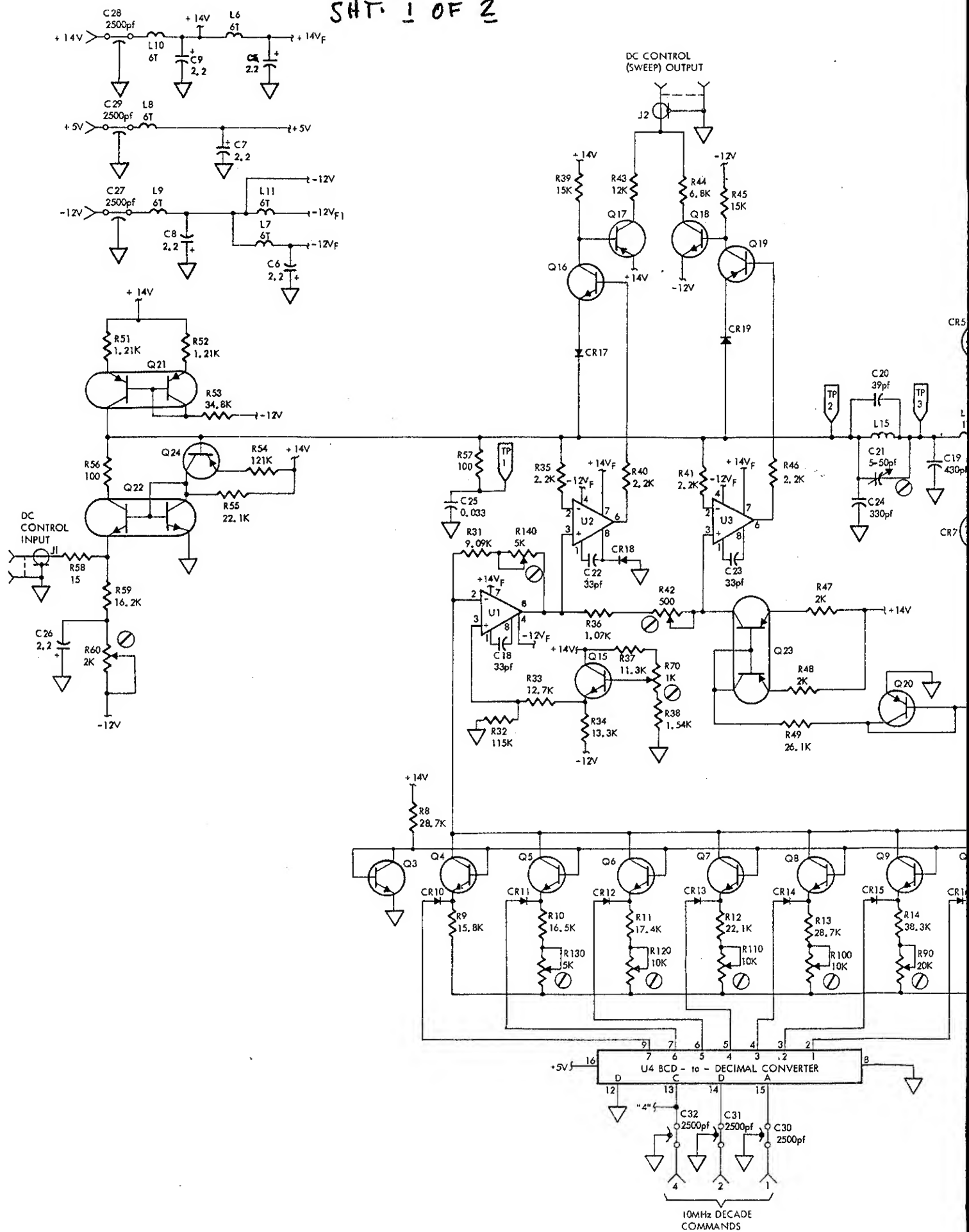
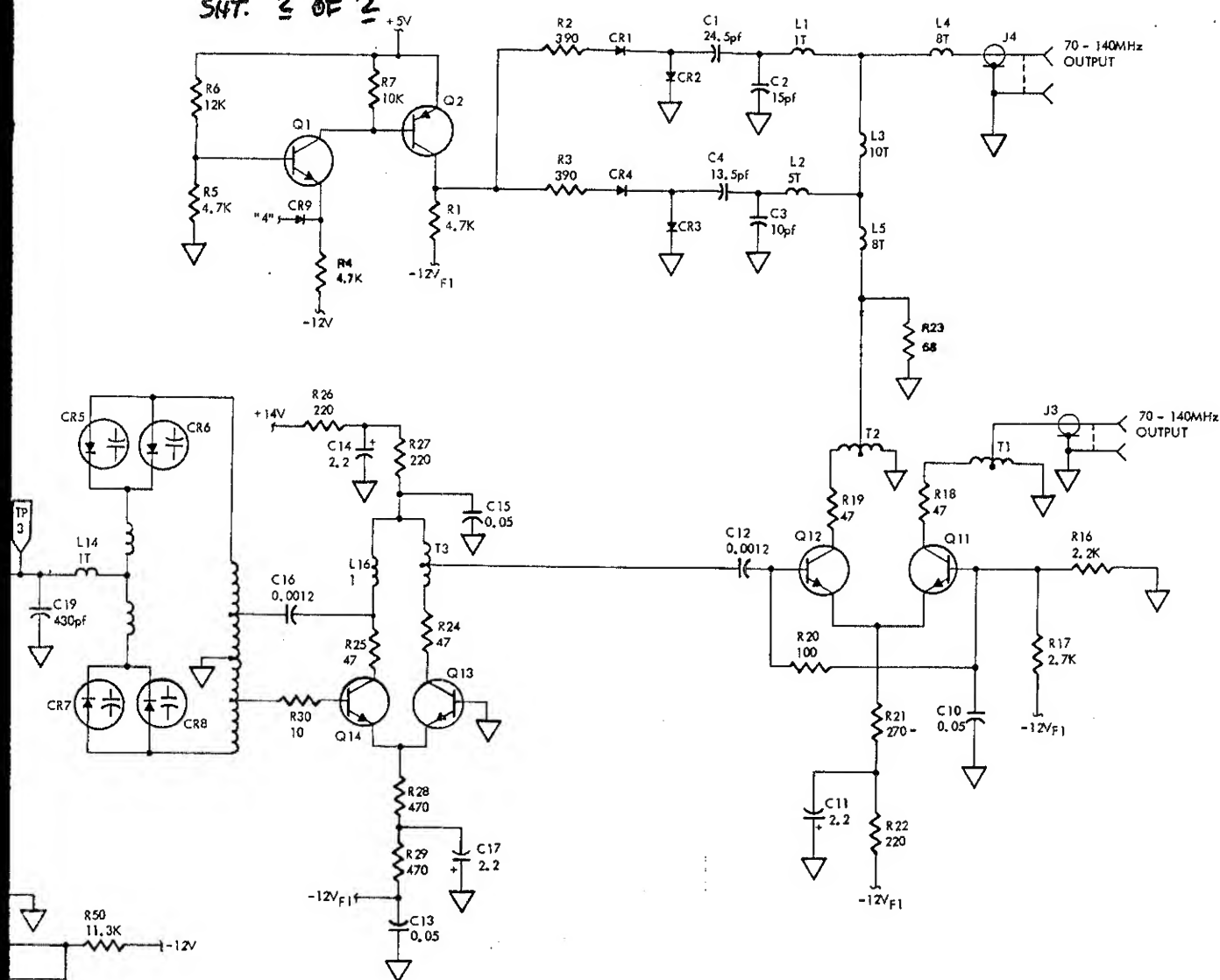


FIG. 8-7
SHT. 2 OF 2

6160B



NOTES:

1. ALL CAPACITOR VALUES ARE IN pf UNLESS NOTED OTHERWISE
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN μ h UNLESS OTHERWISE NOTED.
4. \odot DENOTES INTERNAL ADJUSTMENT

FIGURE 8-7 A5A1 10 MHz STEP LOOP VCO PCB ASSEMBLY (6160A-1007)

FIG. 8-8
SHT. 1 OF 3

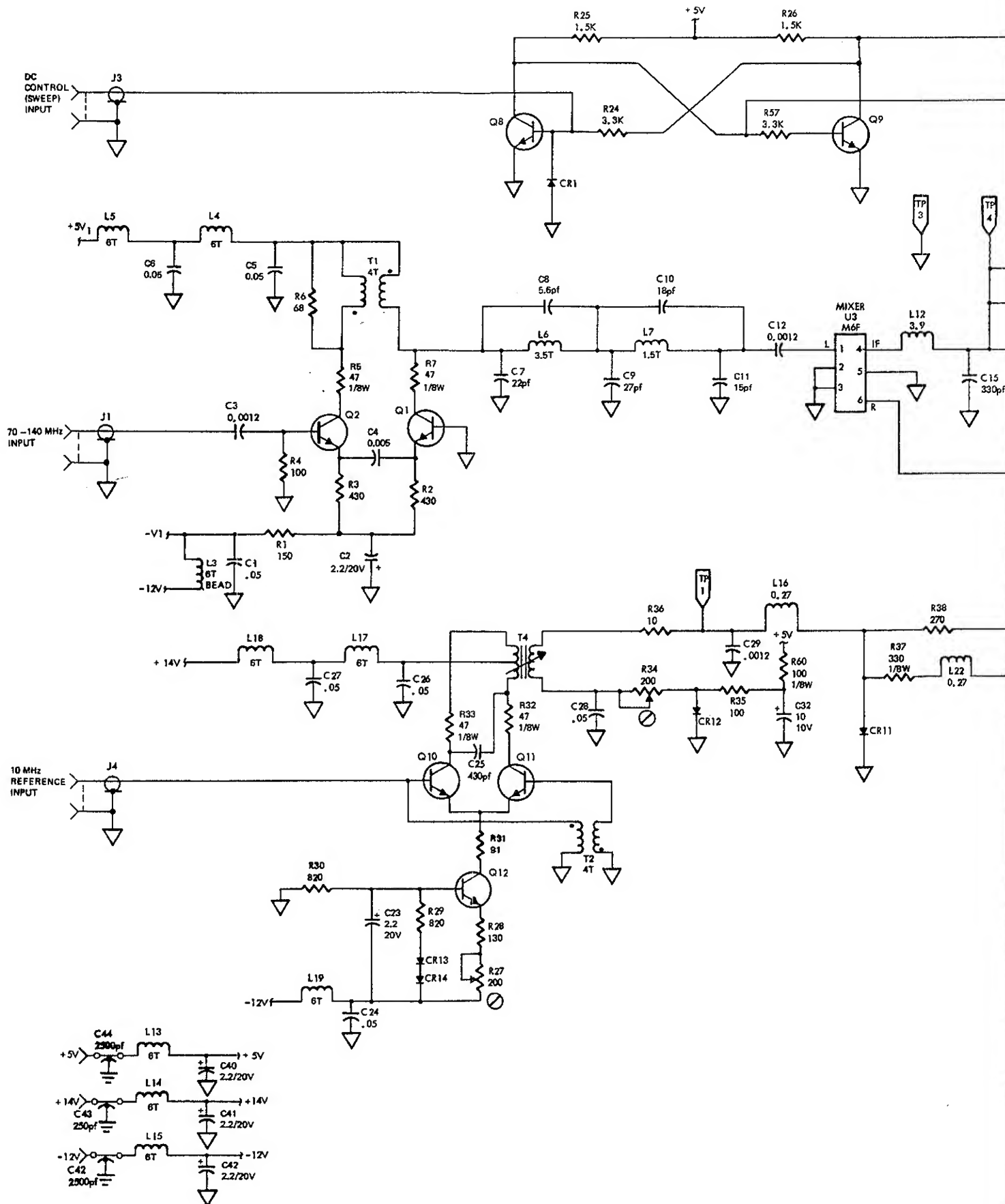


FIG. 8-8
SHT. 3 OF 3

6160B

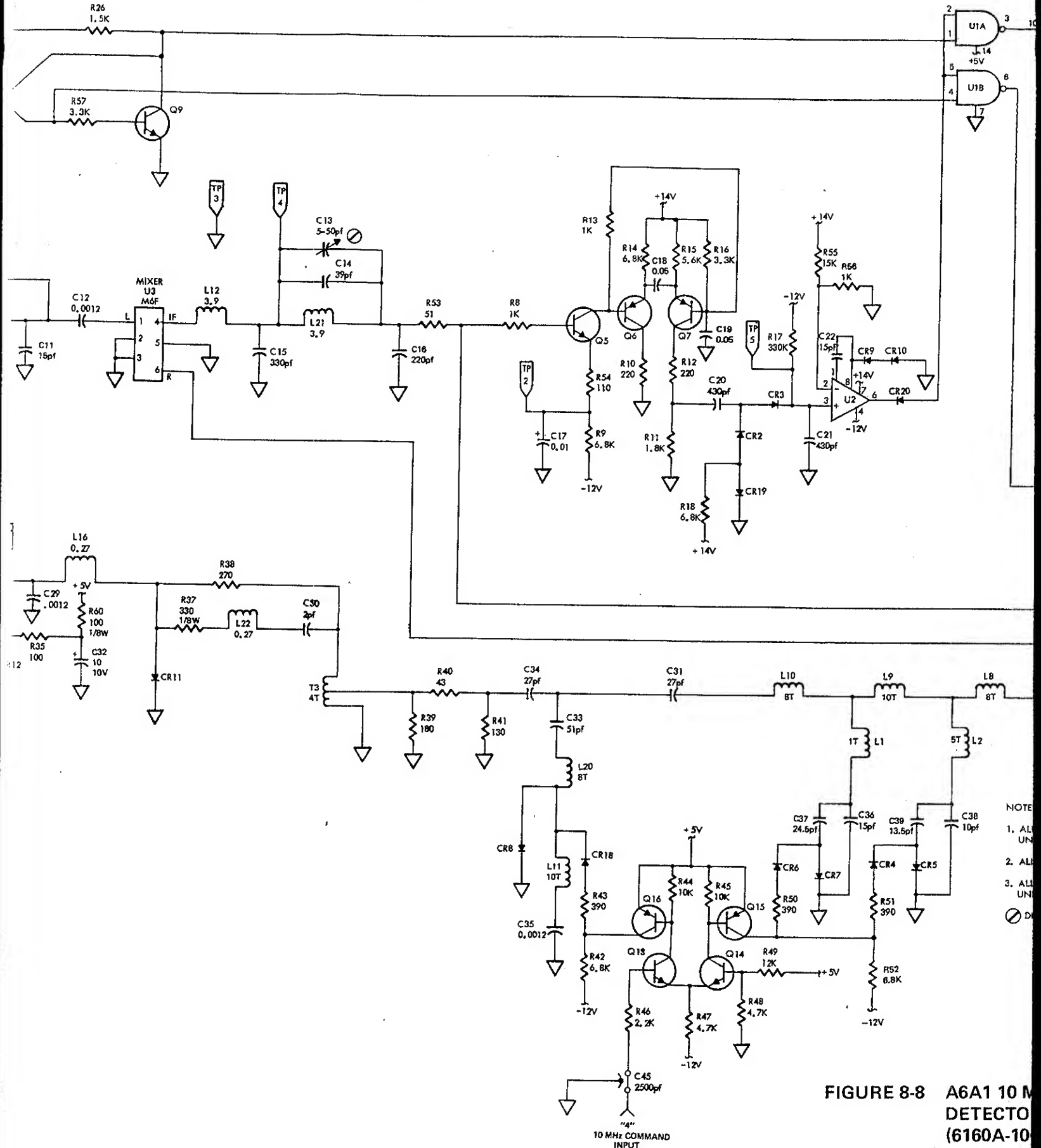


FIGURE 8-8 A6A1 10 M
DETECTO
(6160A-10)

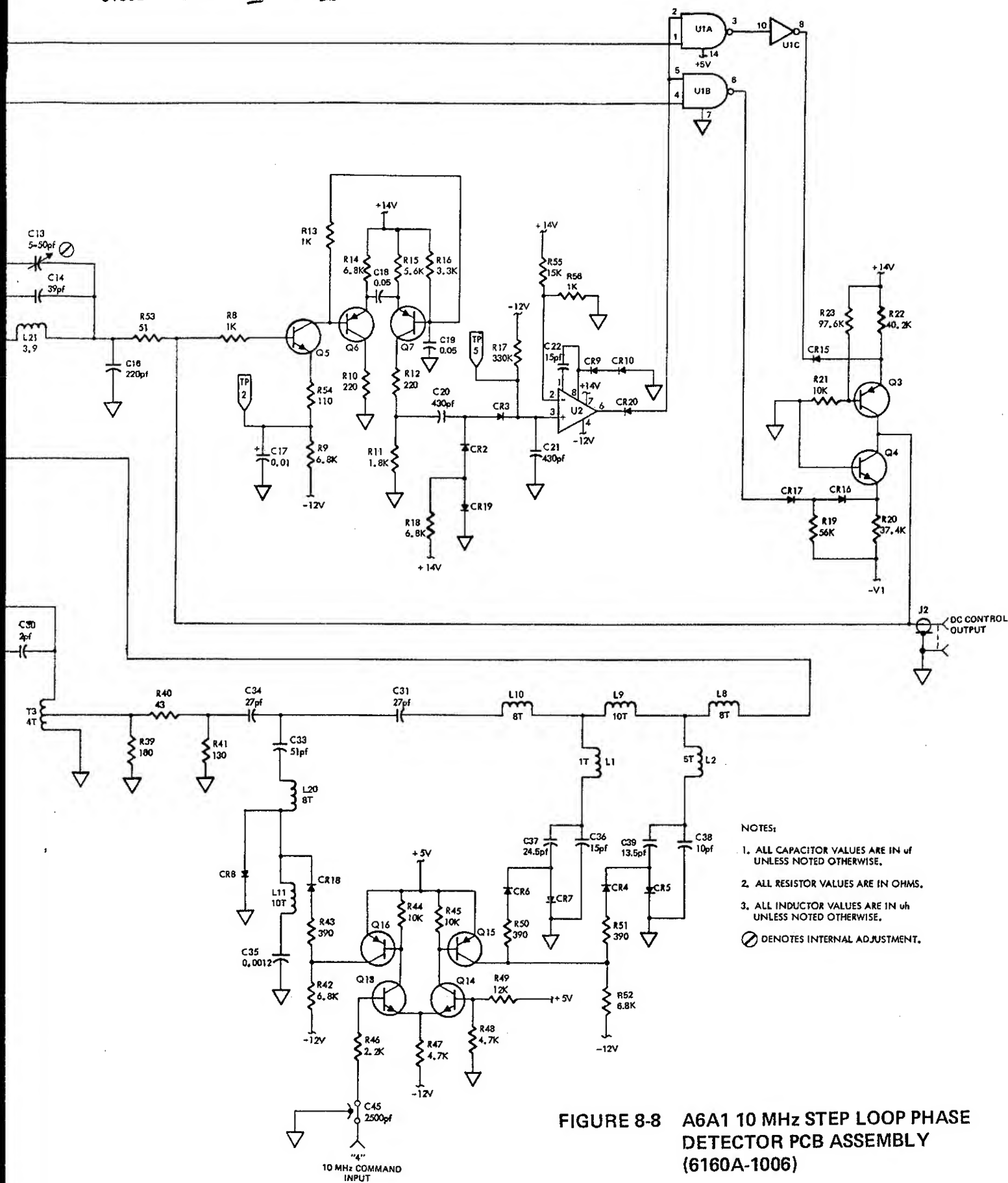
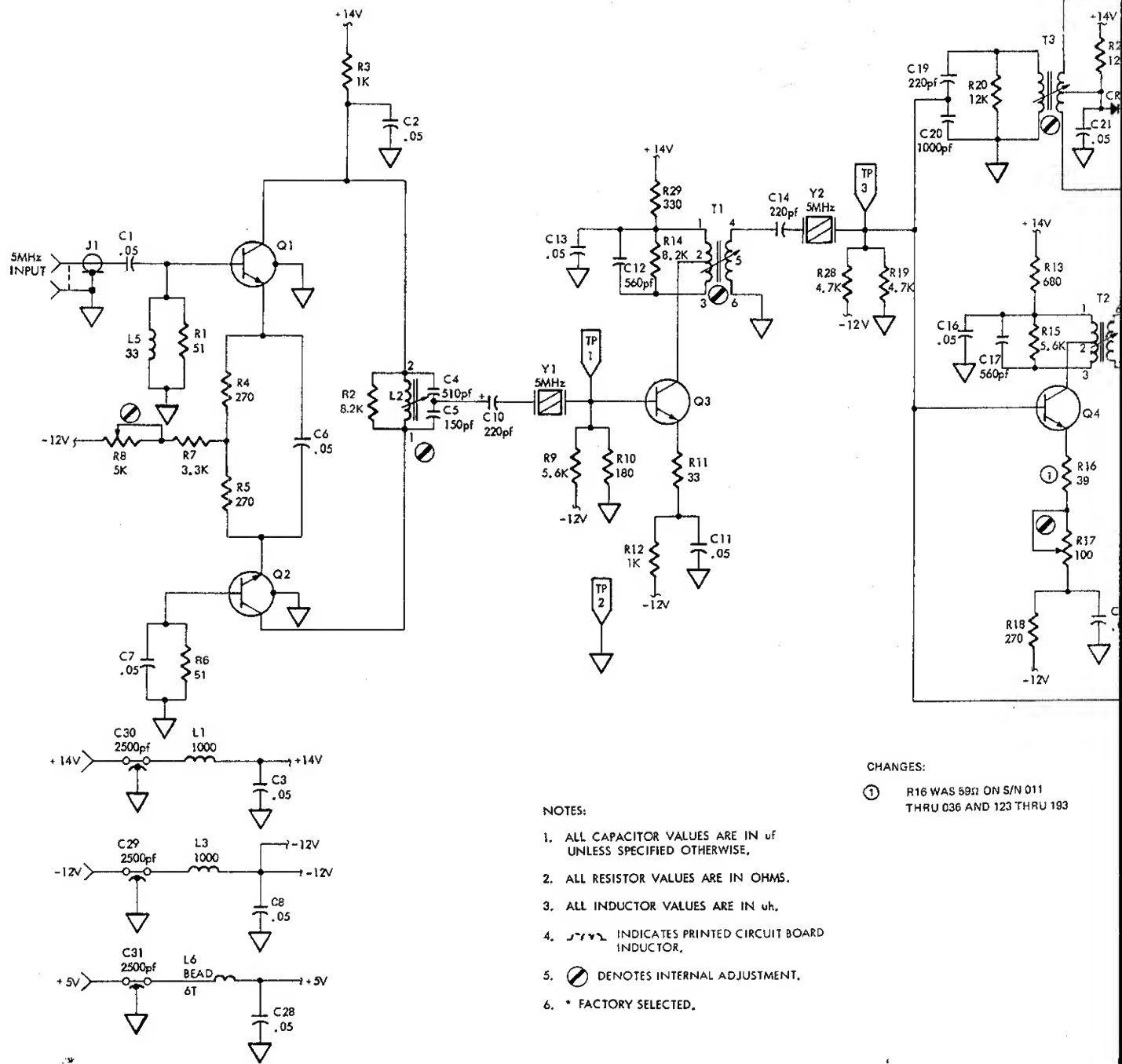


FIG. 8-9
SHT. 1 OF 2



NOTES:

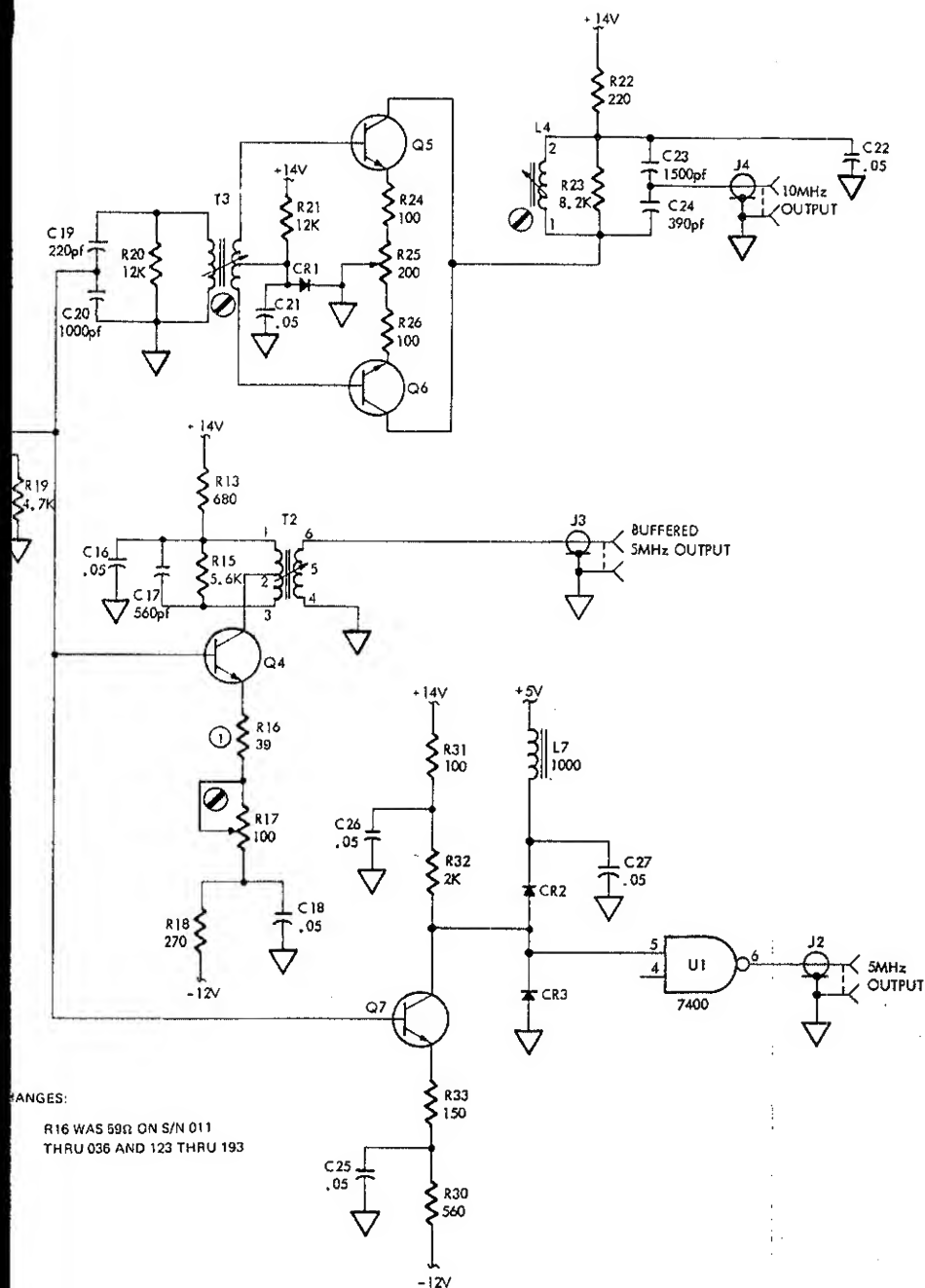
1. ALL CAPACITOR VALUES ARE IN μf UNLESS SPECIFIED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN μh .
4. INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

CHANGES:

- ① R16 WAS 59 Ω ON S/N 011 THRU 036 AND 123 THRU 193

FIG. 8-9
SMT. 3 OF 2

6160B



CHANGES:
R16 WAS 59Ω ON S/N 011
THRU 036 AND 123 THRU 193

FIGURE 8-9 A7A1 INPUT FILTER PCB ASSEMBLY
(6160A-1001)

6160B

FIG. 8-10
SHT. 3 OF 3

NOTES:

1. ALL DECIMAL CAPACITOR VALUES ARE IN μf UNLESS OTHERWISE NOTED.
2. ALL WHOLE NUMBER CAPACITOR VALUES ARE IN P4 UNLESS OTHERWISE NOTED.
3. ALL RESISTOR VALUES ARE IN OHMS.
4. ALL INDUCTOR VALUES ARE IN μh .
5. CR2 AND CR3 ARE MATCHED DIODES.

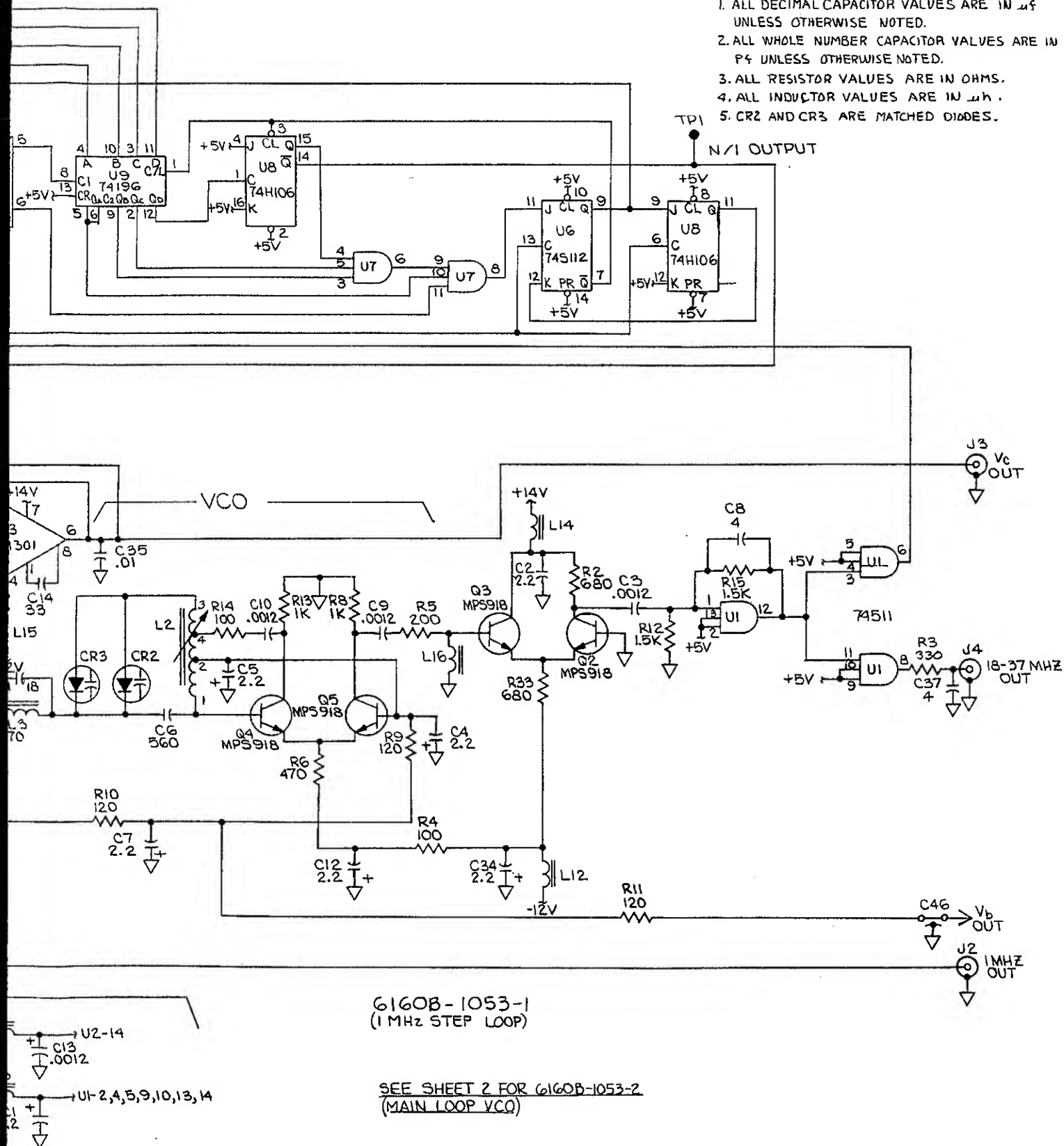
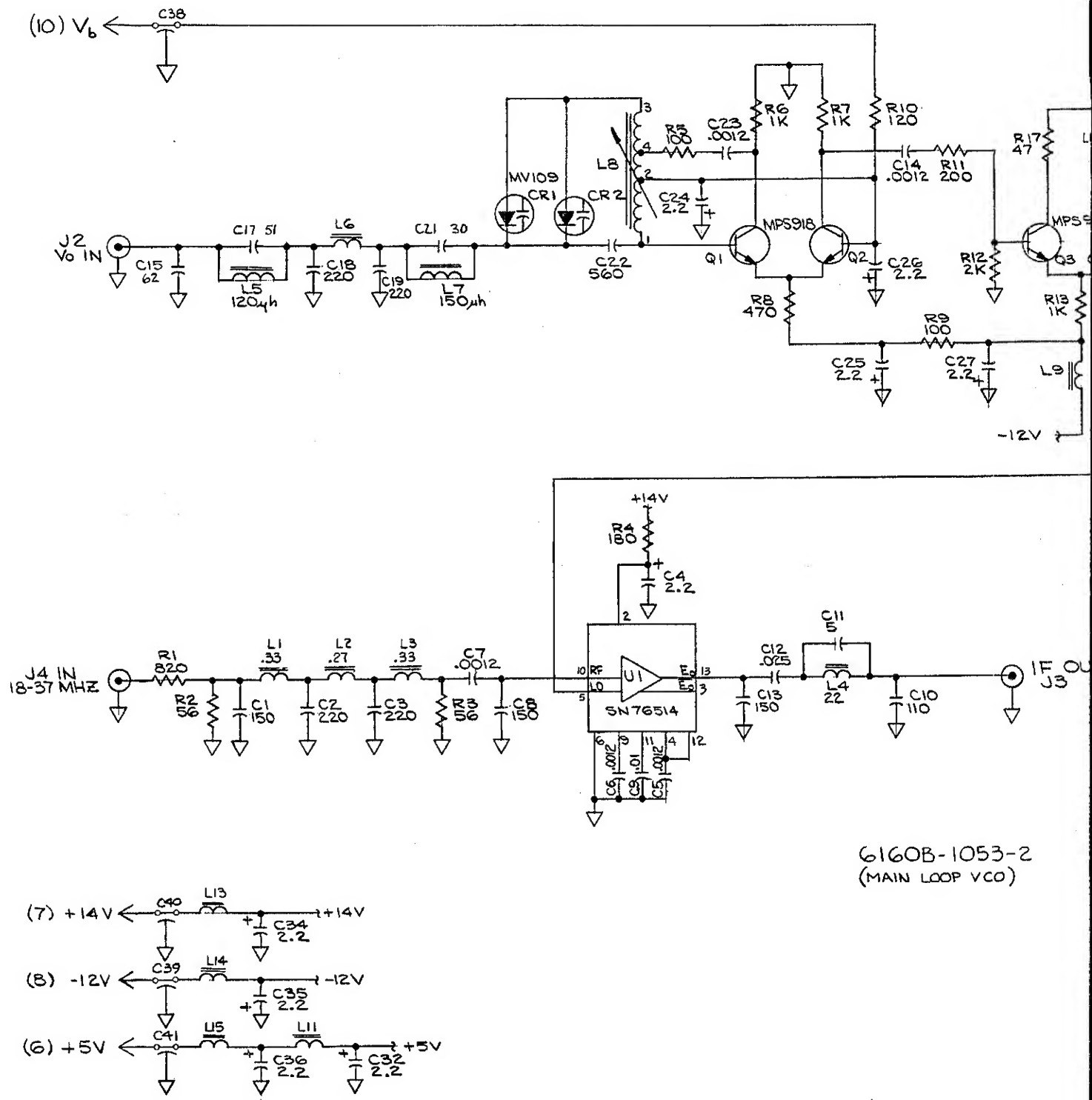
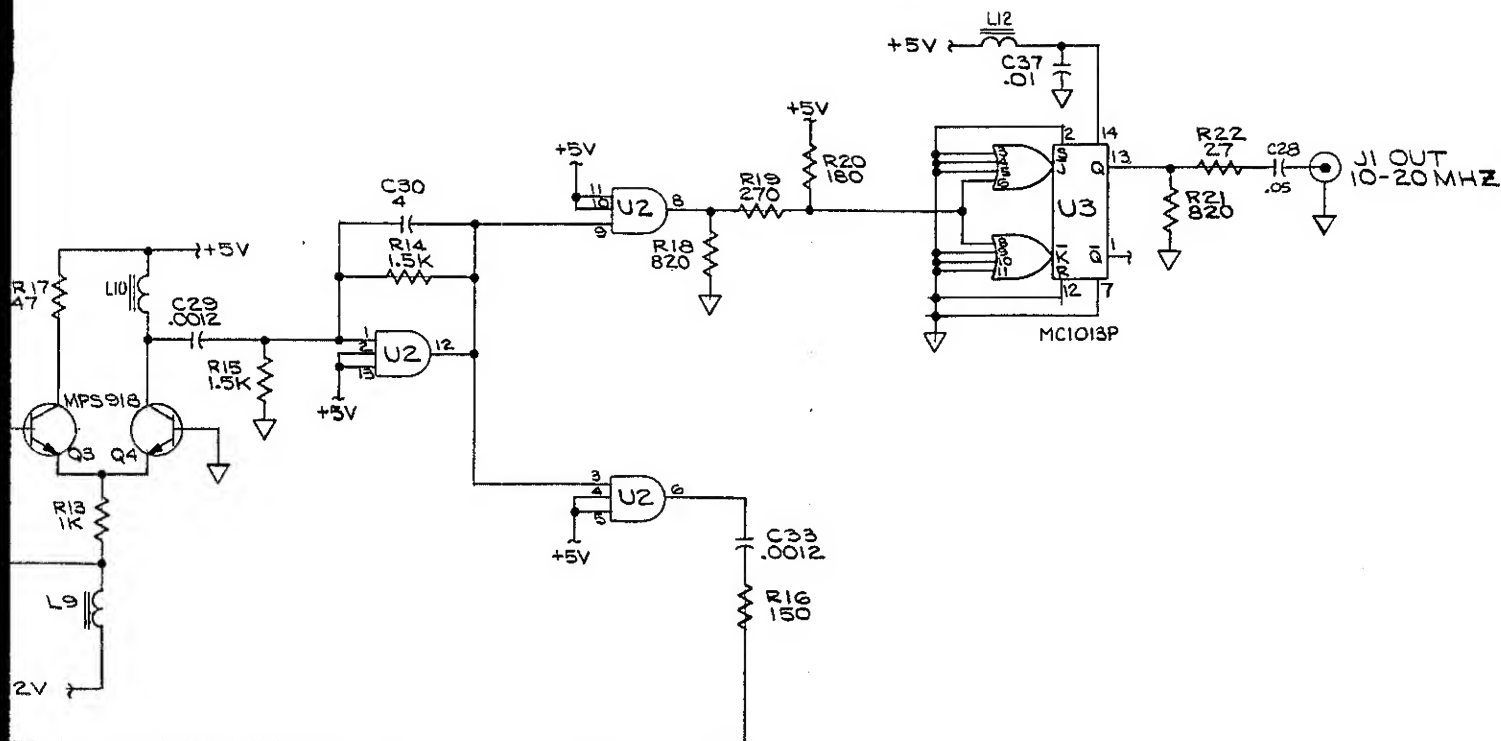


FIGURE 8-10 A8A1A1 1 MHz STEP LOOP PCB
ASSEMBLY (6160B-1053-1)

FIG. 8-11
SHT. 1 OF 2





NOTES:

1. ALL DECIMAL CAPACITOR VALUES ARE IN μf UNLESS OTHERWISE NOTED
2. ALL WHOLE NUMBER CAPACITOR VALUES ARE IN pF UNLESS OTHERWISE NOTED.
3. ALL RESISTOR VALUES ARE IN OHMS.
4. ALL INDUCTOR VALUES ARE IN μh .

LAST NO. USED

R22
C41
U3
L16
Q4
CR2
C16, 20, 31 OPEN

SEE SHEET 1 FOR 6160B-1053-1
1 MHz STEP LOOP

FIGURE 8-11 A8A1A2 1 MHz MAIN LOOP PCB
ASSEMBLY (6160B-1053-2)

FIG. 8-12
SHT. 1 OF 2

6160B NOTES:

1. UNLESS OTHER
RESISTOR V
CAPACITOR
DIODES ARE
2. LAST USED RE
C28, C23, L

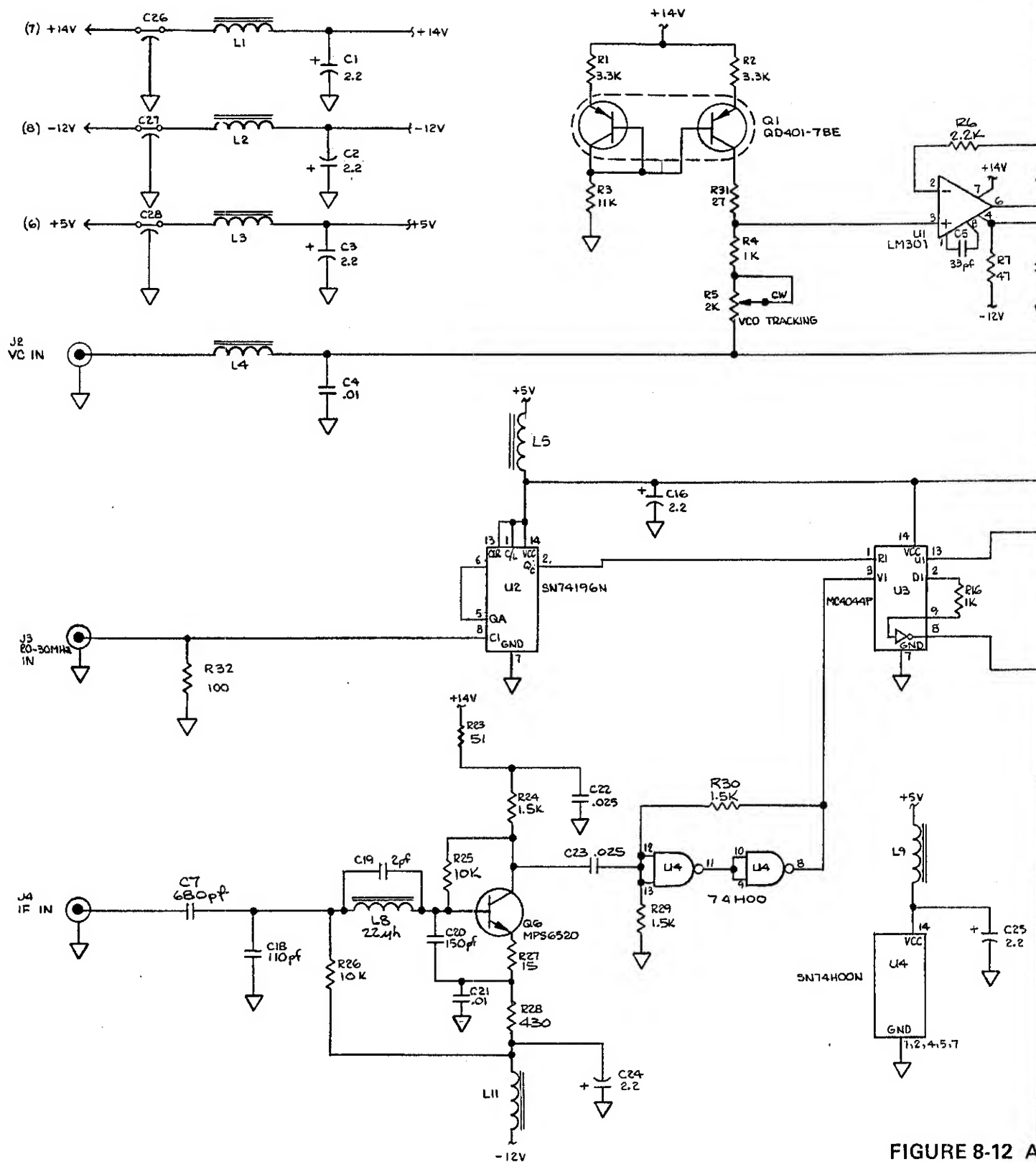


FIGURE 8-12 A
D
(6

FIG. 8-12

SHT. 2 OF 2

6160B NOTES:

1. UNLESS OTHERWISE NOTED:
RESISTOR VALUES ARE IN OHMS.
CAPACITOR VALUES ARE IN MICROFARADS.
DIODES ARE JF203323.
2. LAST USED REFERENCE DESIGNATIONS ARE AS FOLLOWS:
C28, C23, L10, Q6, R31, U4.

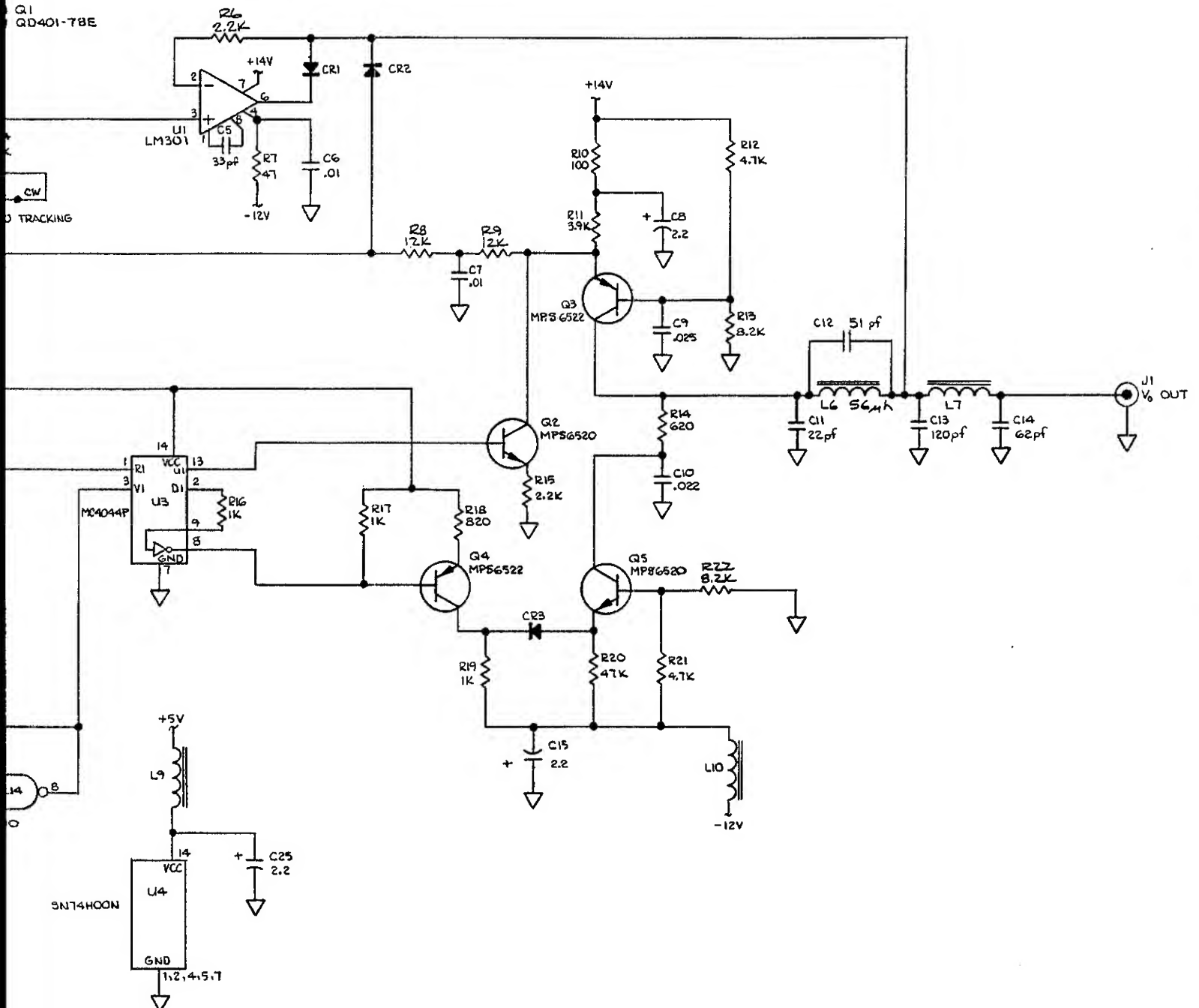


FIGURE 8-12 A8A2A1 1 MHz MAIN LOOP PHASE
DETECTOR PCB ASSEMBLY
(6040A-1004)

FIG. 8-13
SHT. 1 OF 2

NOTES:

- 1). UNLESS O
A). ALL CA
B). ALL R
C). ALL IN
D). ALL G

- 2).  CR1 & C

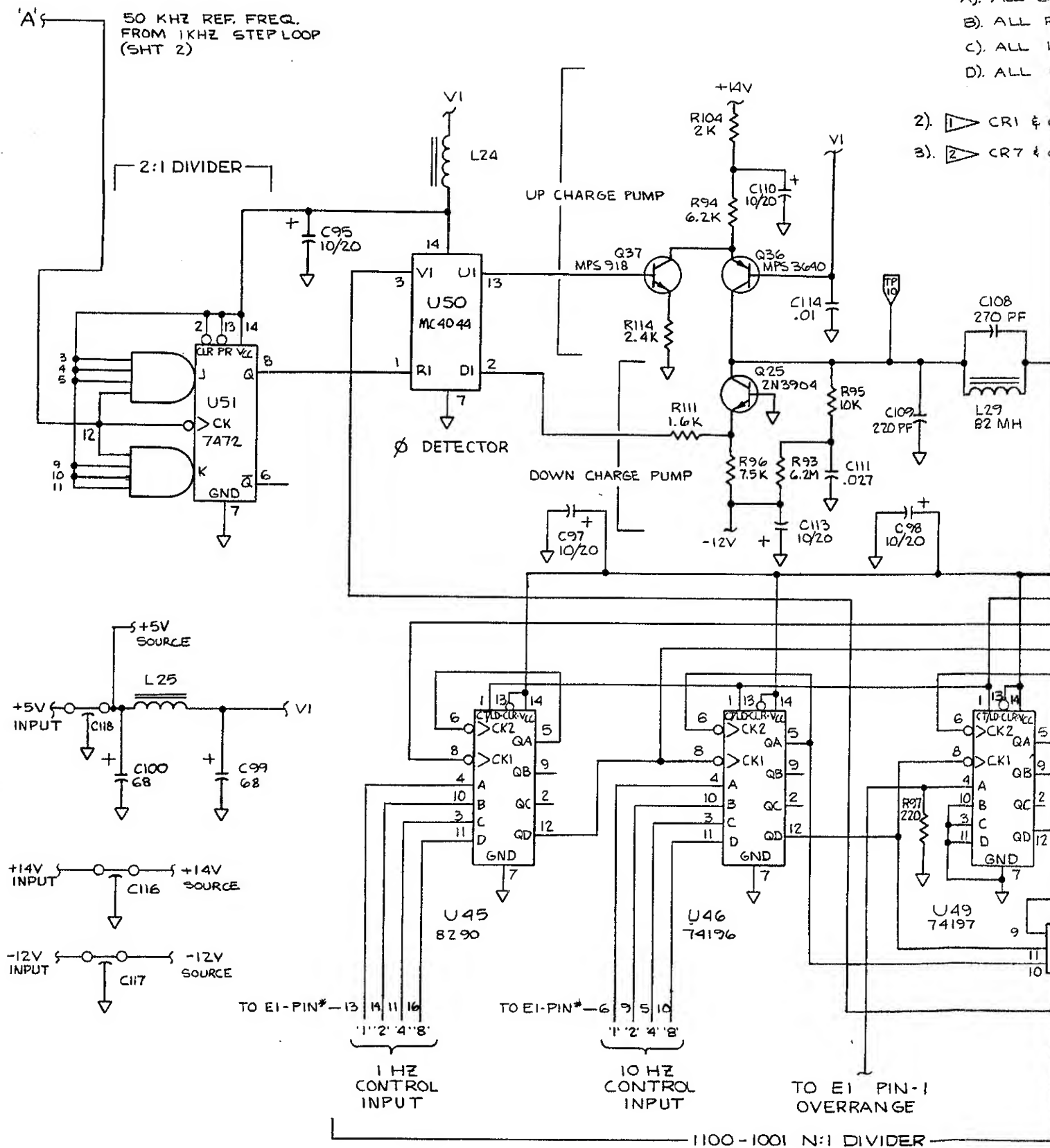


FIG. 8-13
SHT. 3 OF 2

6160B

AS OTHERWISE SPECIFIED:

ALL CAPACITOR VALUES ARE IN MICROFARADS.

ALL RESISTOR VALUES ARE IN OHMS.

ALL INDUCTOR VALUES ARE IN MICROHENRIES.

ALL GATE I.C.'S: PIN 14 - FILTERED +5V,
PIN 7 - GND

Q1 & CR2 ARE A MATCHED PAIR.

Q7 & CR10 ARE A MATCHED PAIR.

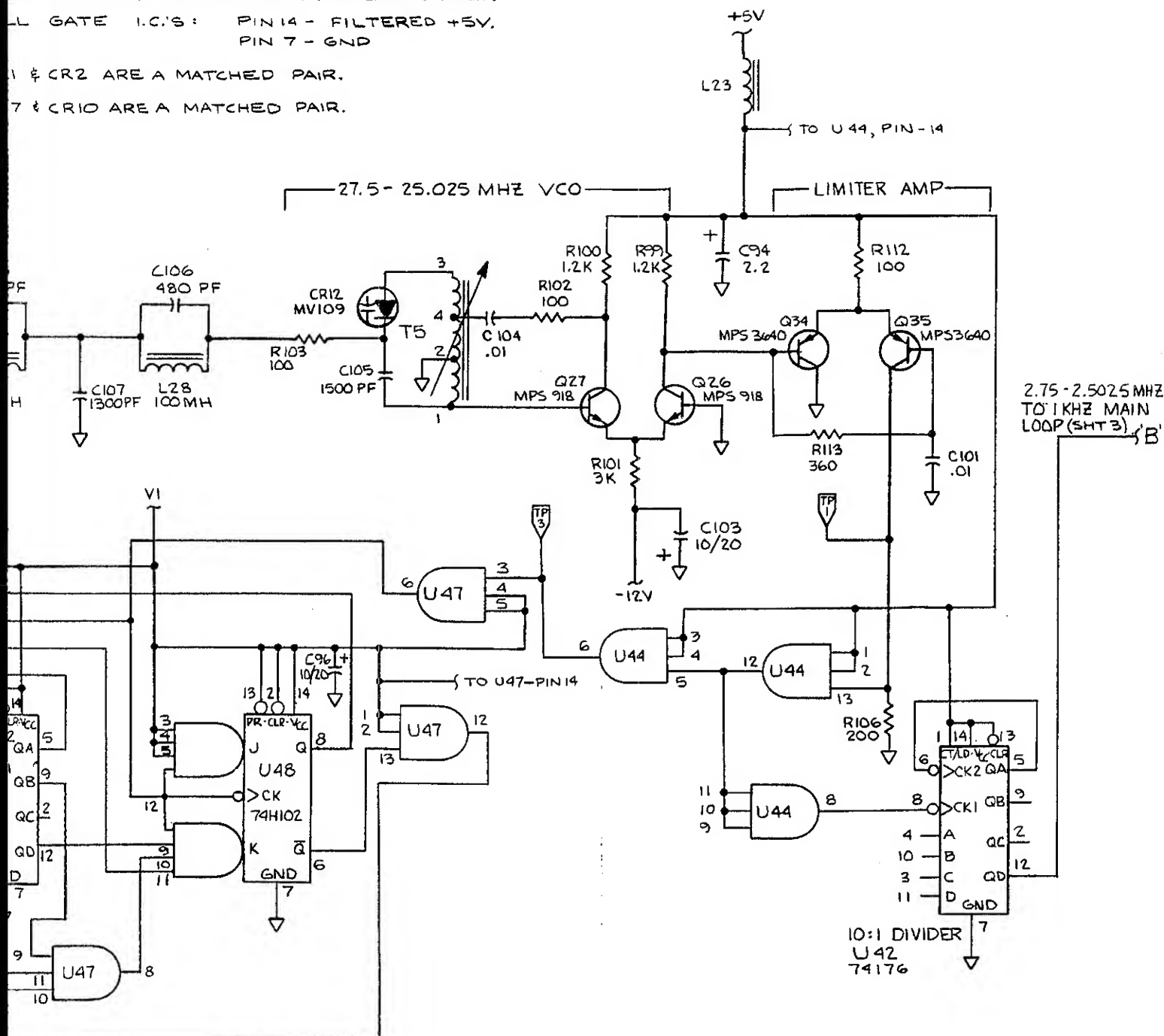


FIGURE 8-13 (1 of 5) A9A1 SIX DIGIT GENERATOR
PCB ASSEMBLY (6040A-1002)

FIG. 8-13a
SHT. 1 OF 2

6160B

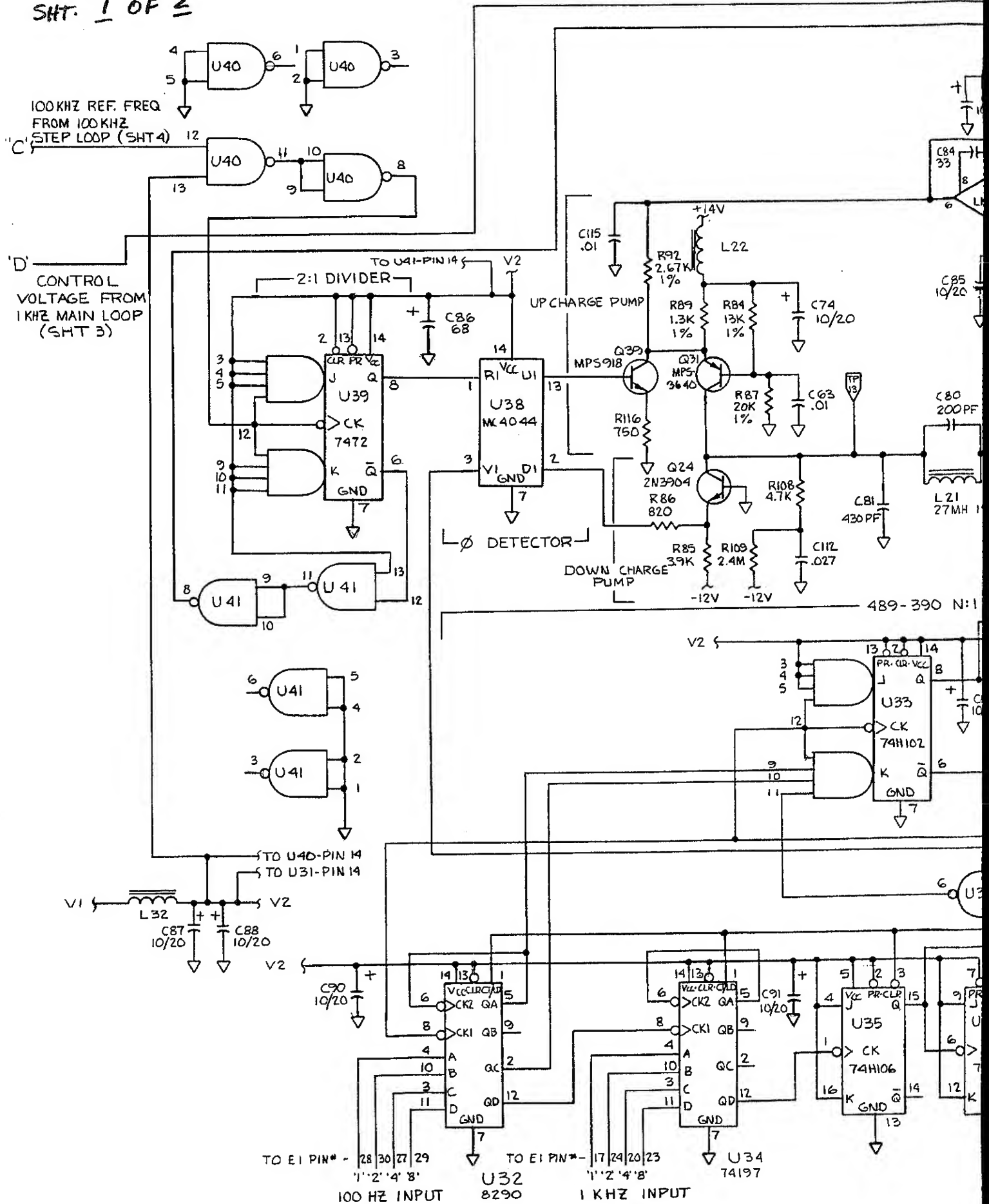


FIG. 8-13a
SHT. 2 OF 2

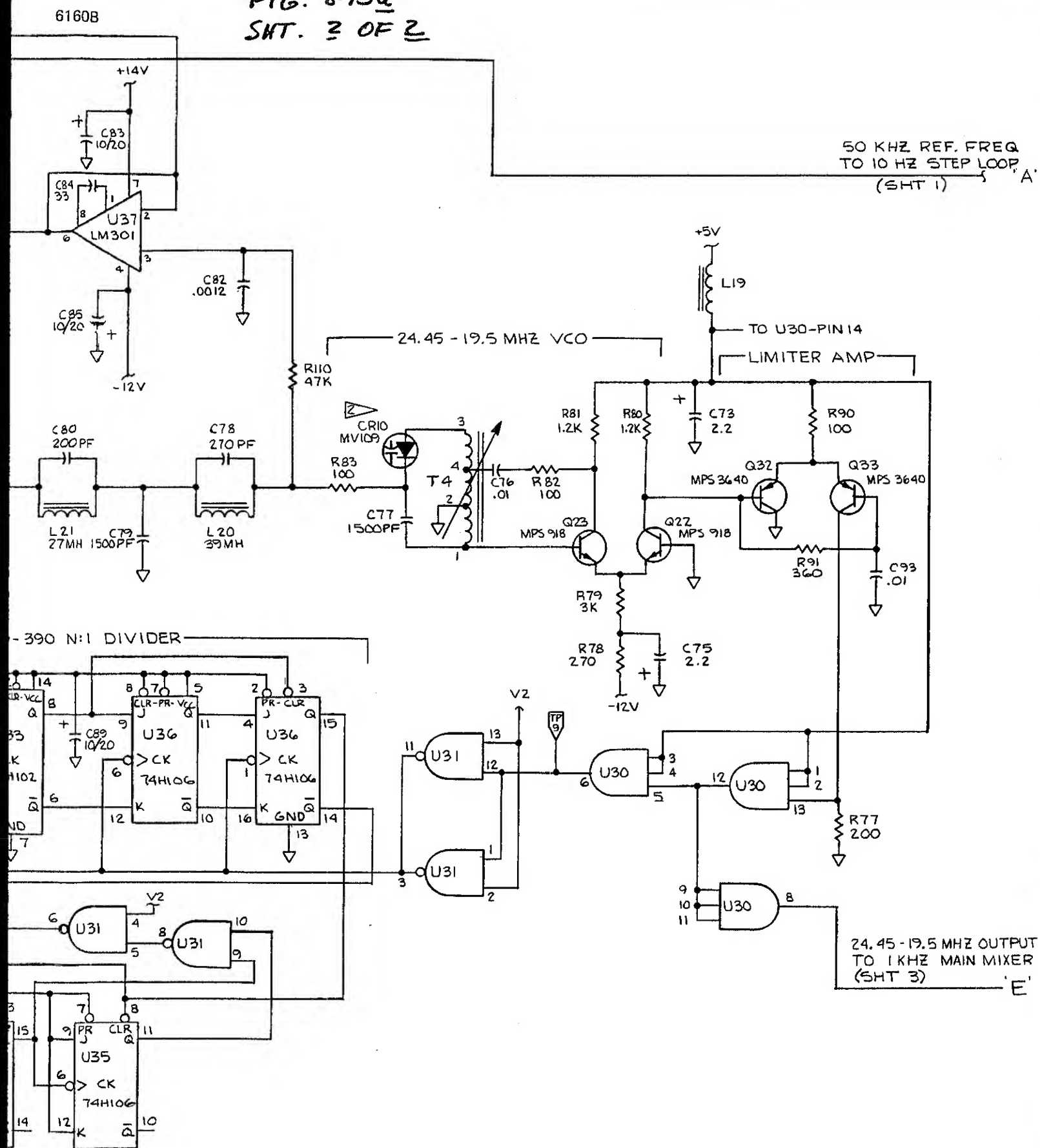


FIGURE 8-13 (2 of 5) A9A1 SIX DIGIT GENERATOR
PCB ASSEMBLY (6040A-1002)

FIG. 8-13b

SHT. 1 OF 2

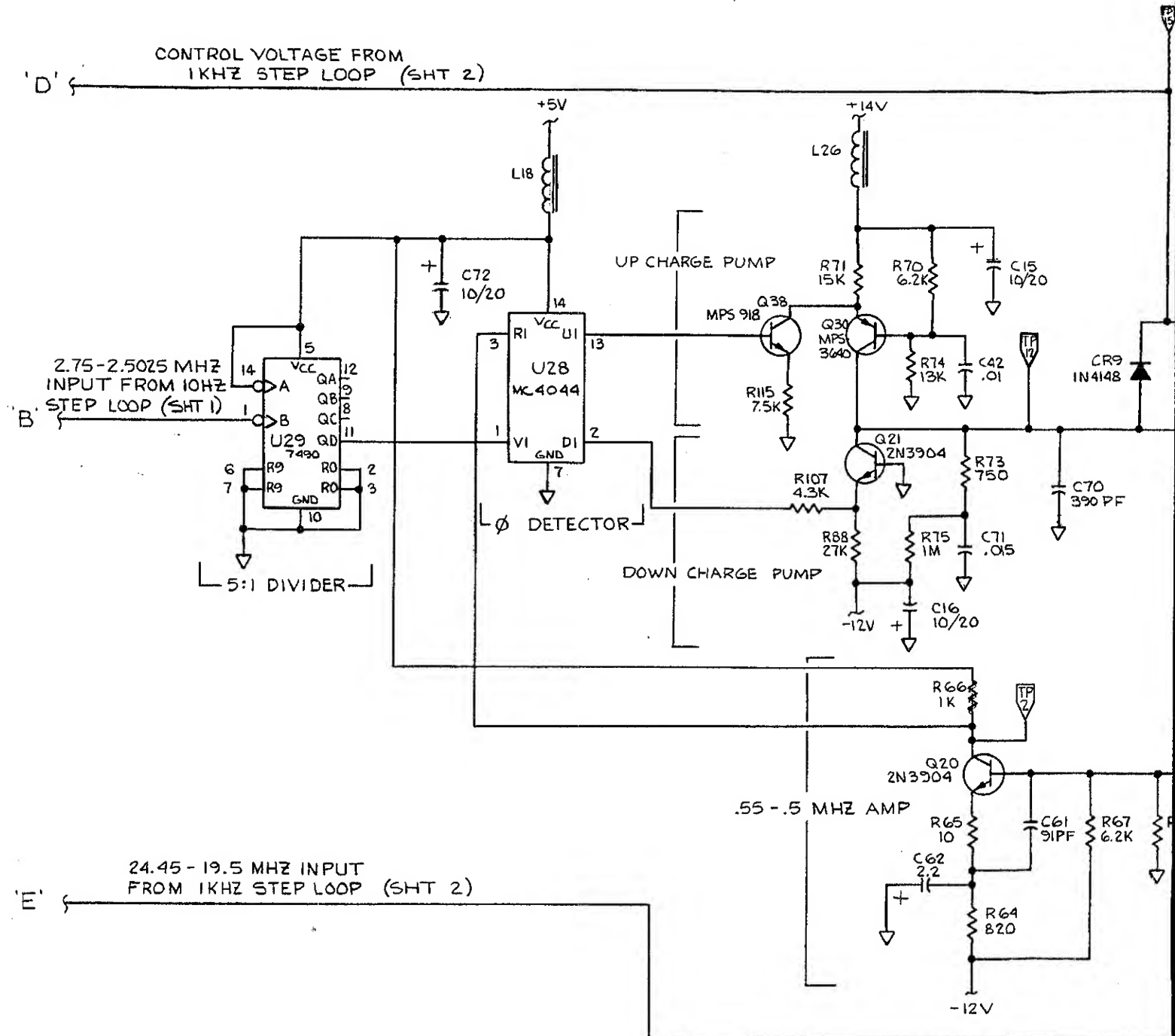


FIG. 8-13b
SHT. 2 OF 2

6160B

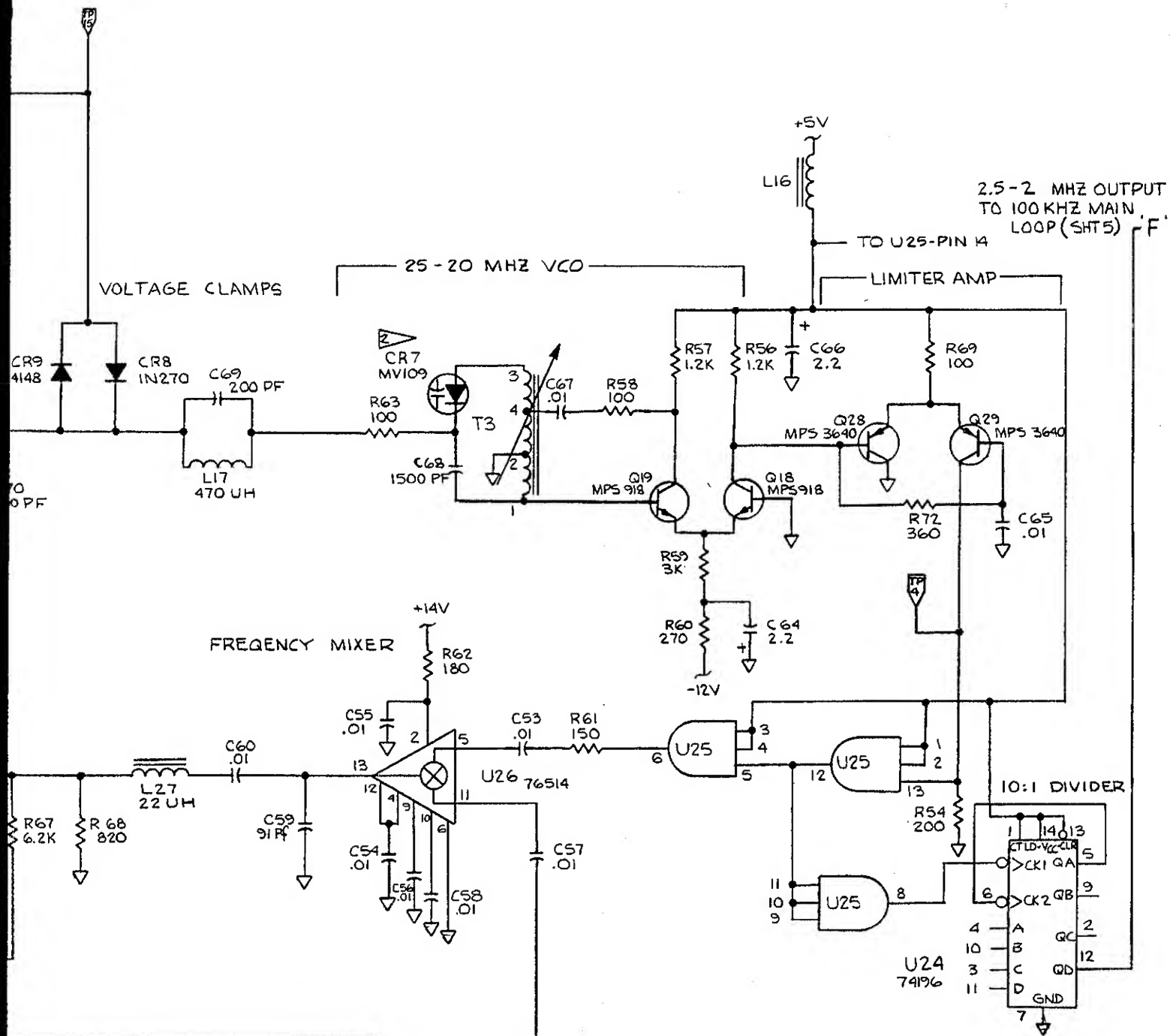


FIGURE 8-13 (3 of 5) A9A1 SIX DIGIT GENERATOR
PCB ASSEMBLY (6040A-1002)

FIG. 8-13 c

SHT. 1 OF 2

6160B

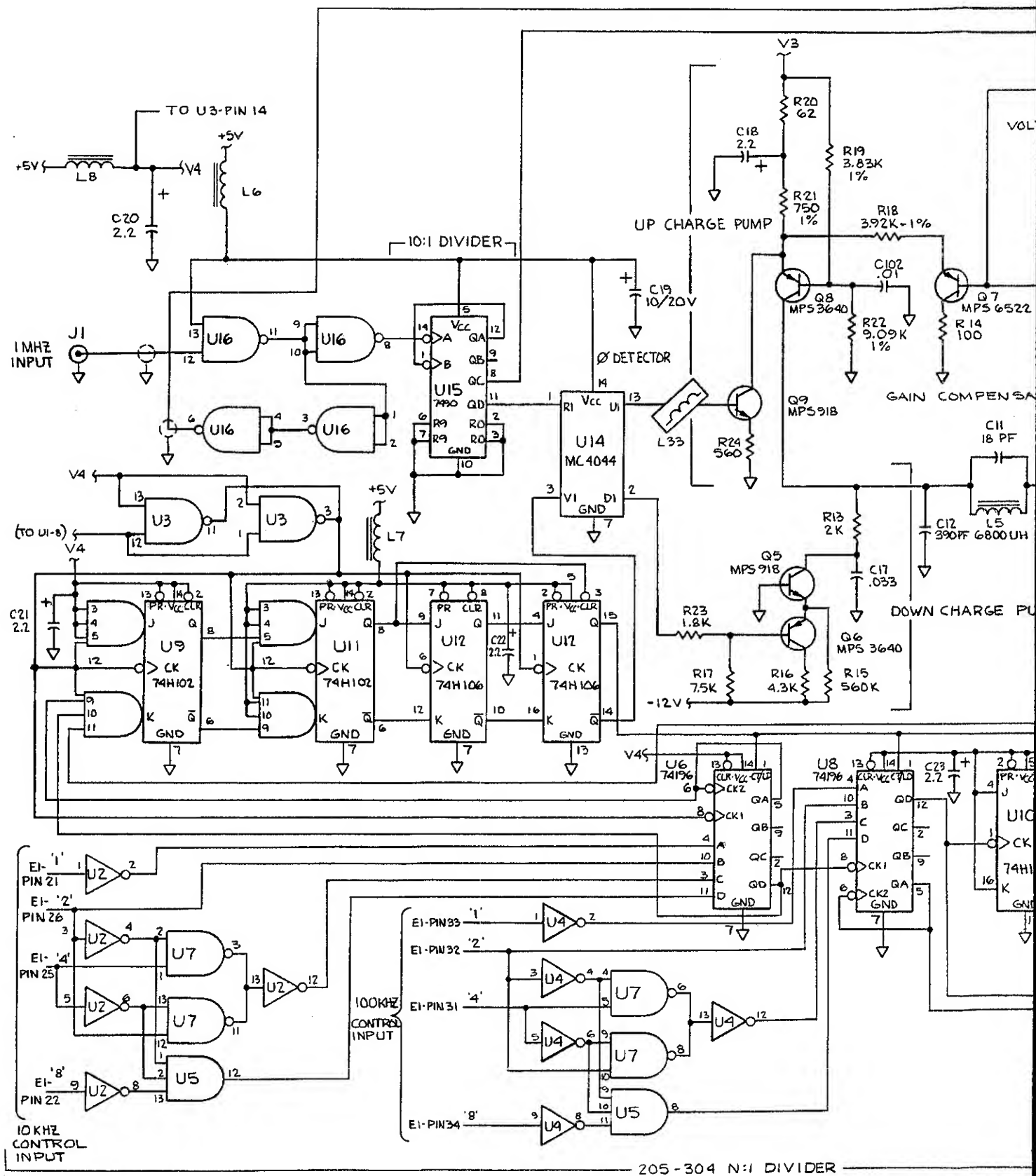


FIG. 8-13c

SHT. 3 OF 2

61608

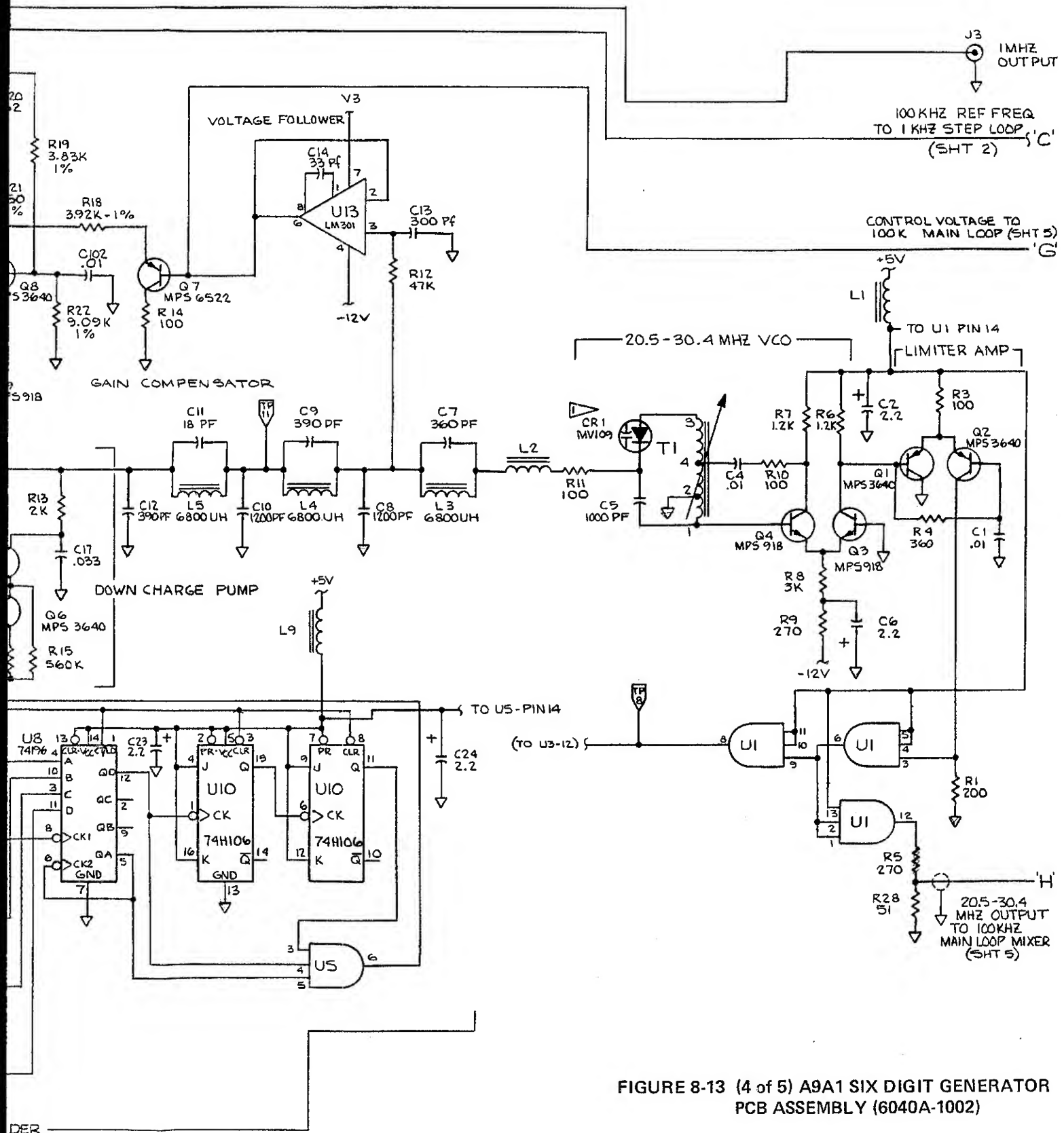


FIGURE 8-13 (4 of 5) A9A1 SIX DIGIT GENERATOR
PCB ASSEMBLY (6040A-1002)

FIG. 8-13 d
SHT. 1 OF 2

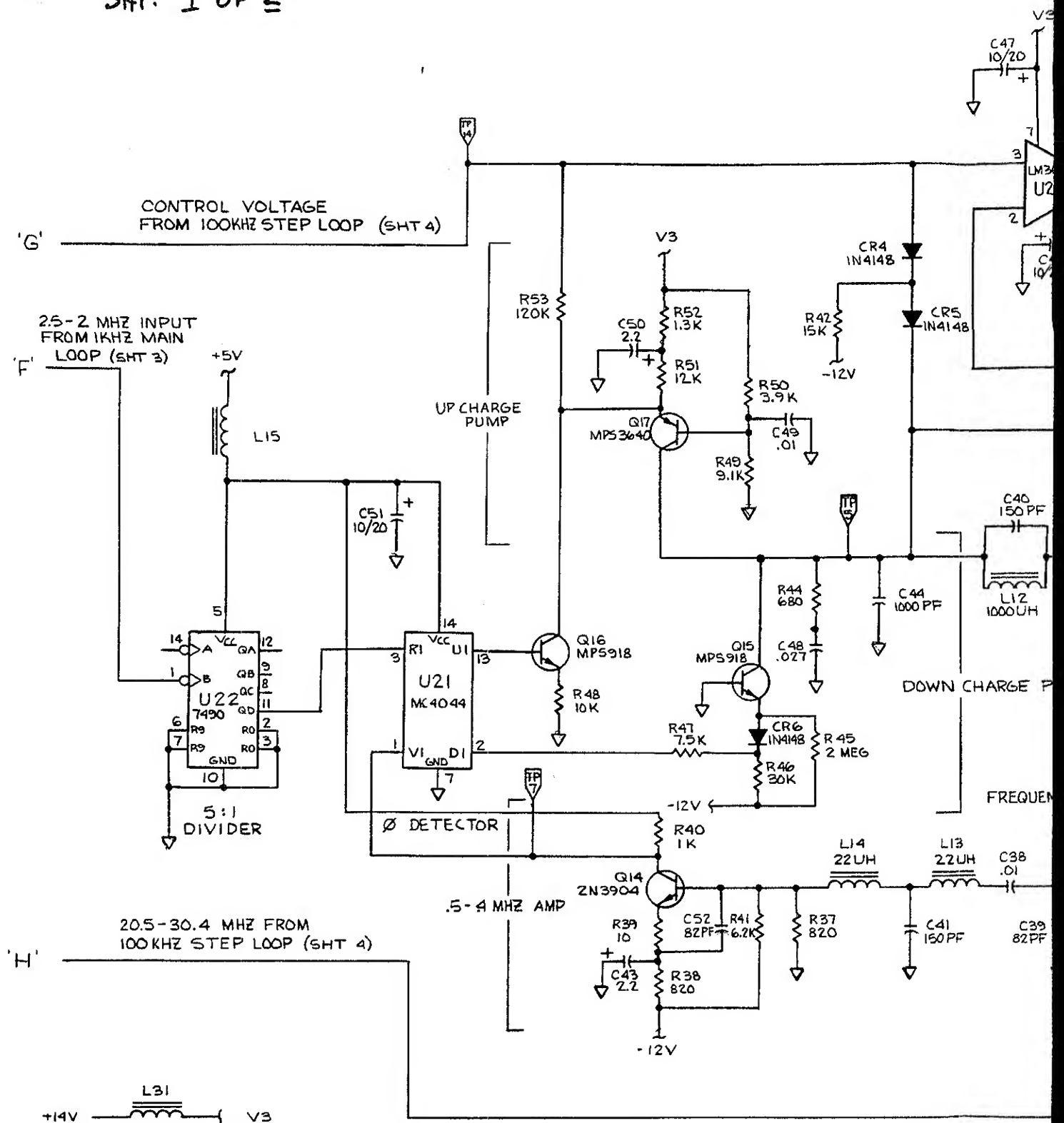


FIG. 8-13 d
SHT. 2 OF 2

6160B

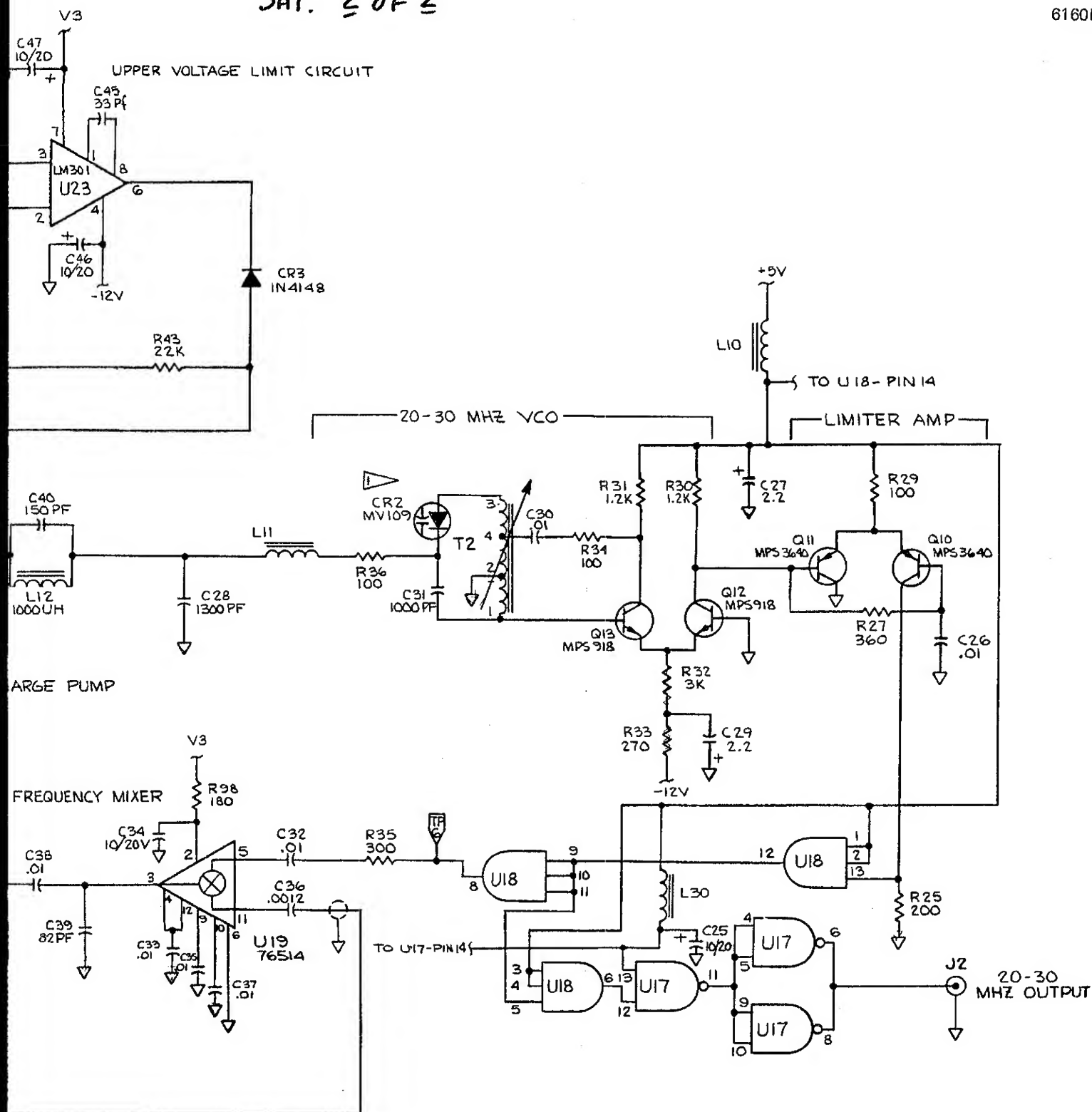


FIGURE 8-13 (5 of 5) A9A1 SIX DIGIT GENERATOR
PCB ASSEMBLY (6040A-1002)

FIG. 8-14
SHY. 1 OF 2

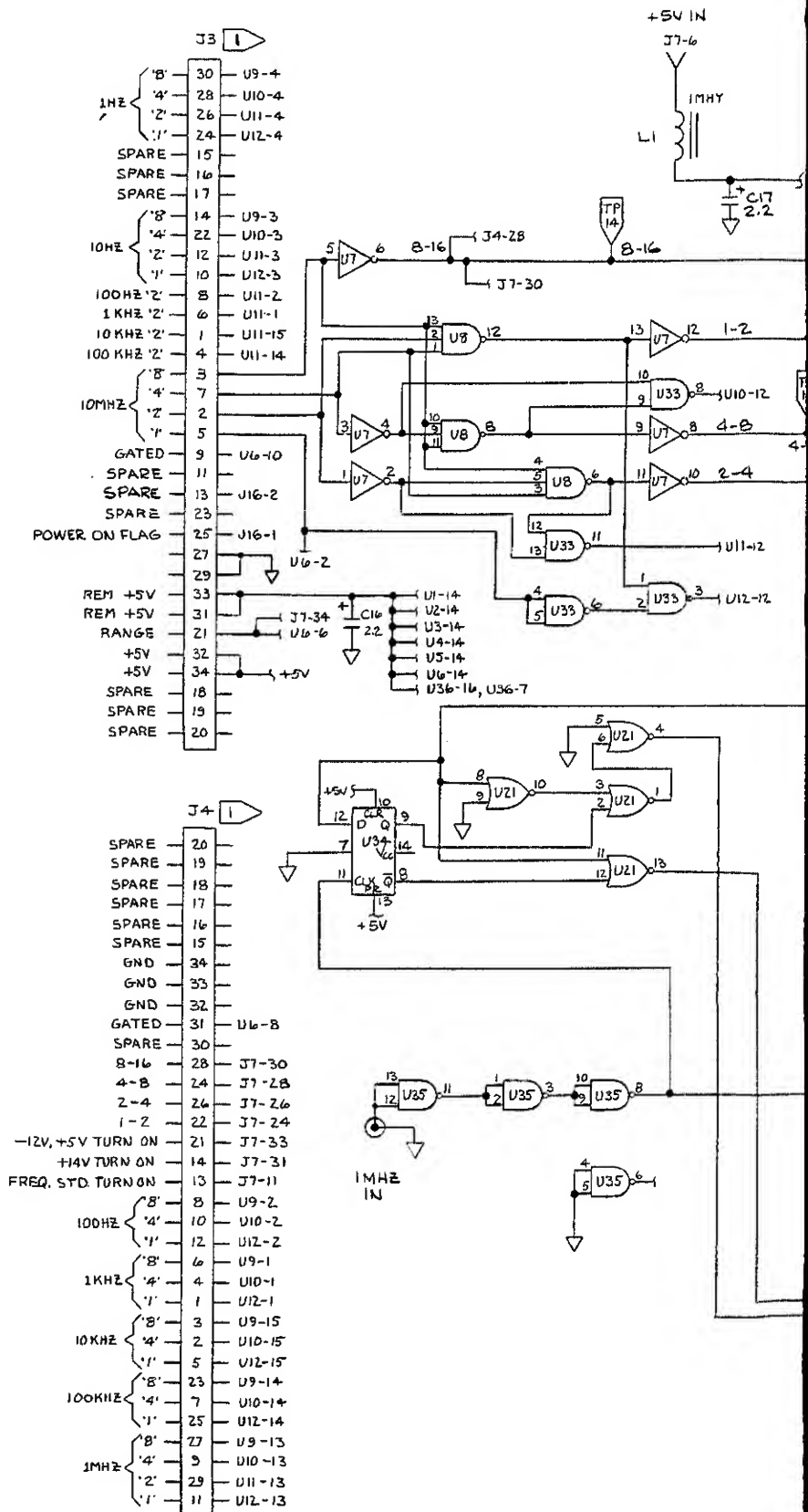
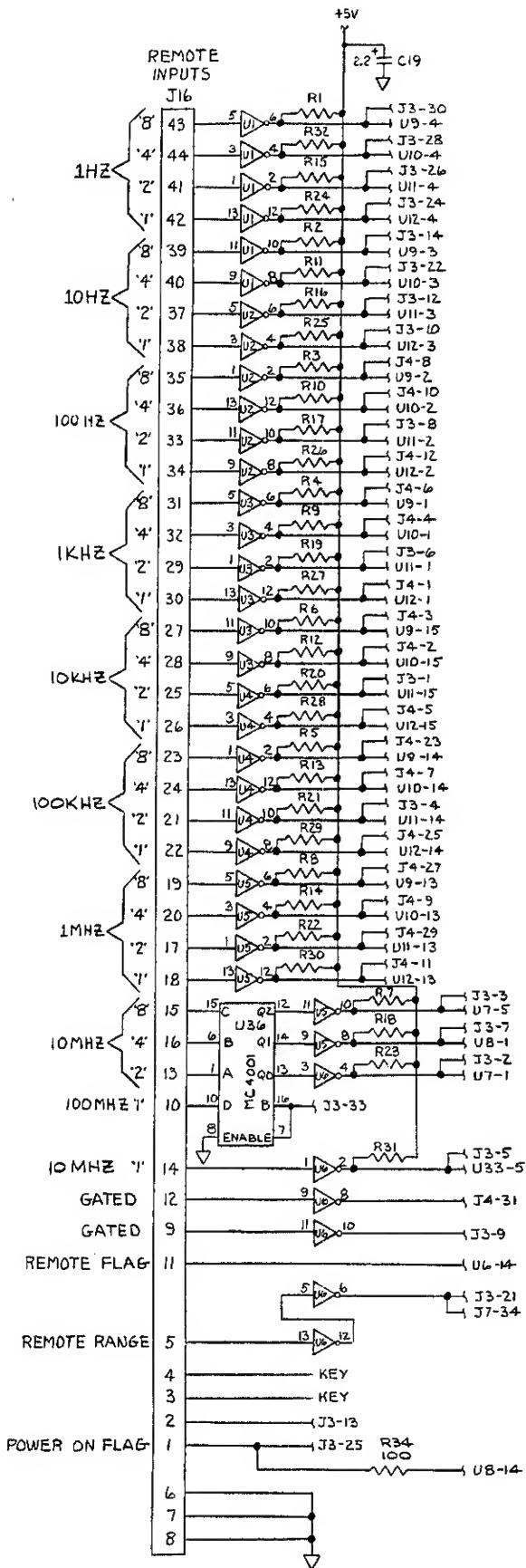
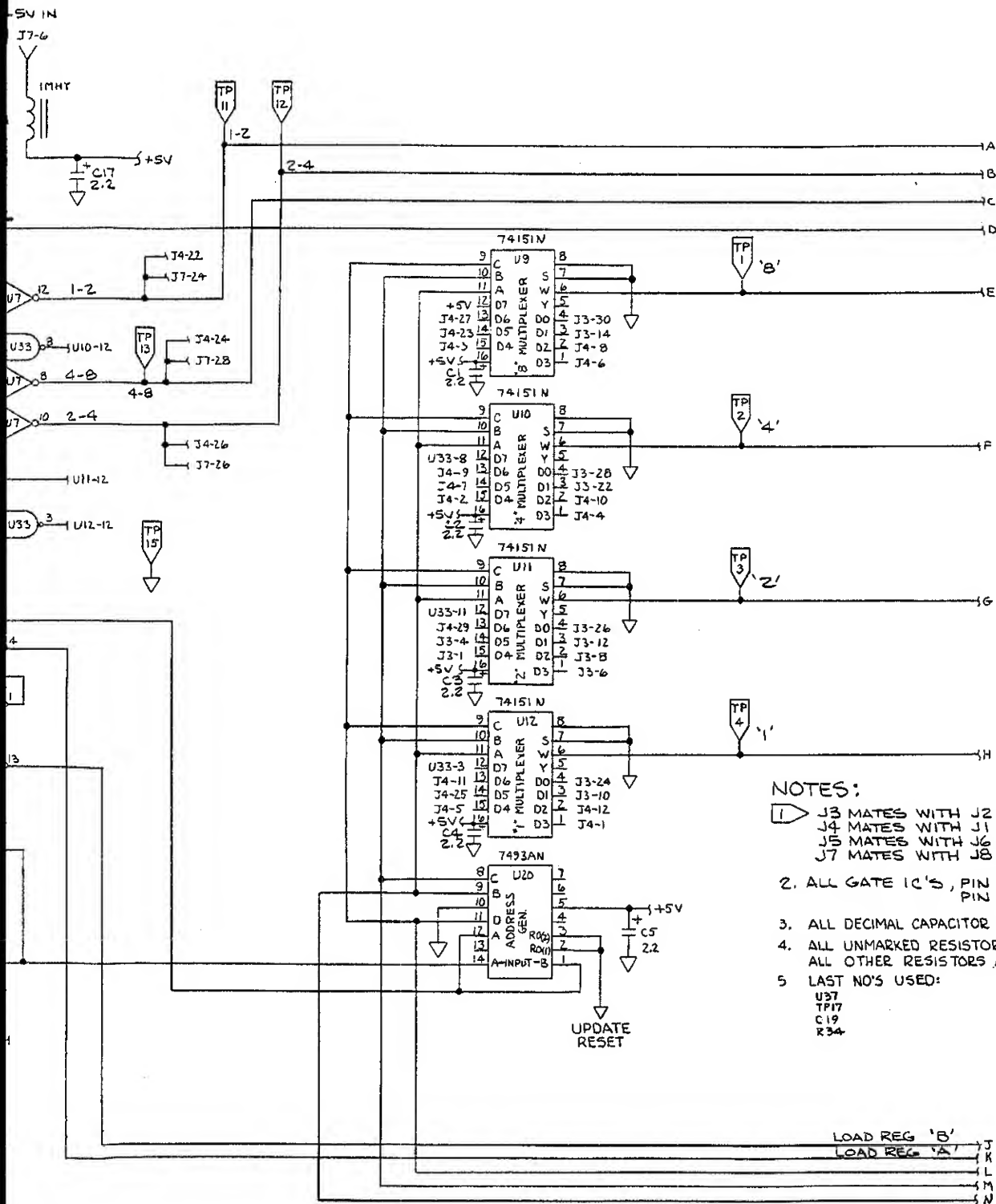


FIG. 8-14
SHT. 2 OF 2

6160B



NOTES:

1. J3 MATES WITH J2 FRONT PANEL (6160A-405)
J4 MATES WITH J1 FRONT PANEL (6160A-405)
J5 MATES WITH J6 1-100 KHZ D.CEN (6040A-4002)
J7 MATES WITH J8 MOTHER BOARD (6160B-4013)
2. ALL GATE IC'S, PIN 14 - +5V
PIN 7 - GND
3. ALL DECIMAL CAPACITOR VALUES ARE IN MICROFARADS.
4. ALL UNMARKED RESISTORS ARE 6.8K, 1/8W, 5%
ALL OTHER RESISTORS ARE 1/4W, 5%
5. LAST NO'S USED: NOT USED:
U37 U24, 26, 27
TP17 C10
C19 R33
R34

FIGURE 8-14 (1 of 2) A10 COMPUTER PCB
ASSEMBLY (6160B-1012)

FIG. 8-14a
SHT. 1 OF 2

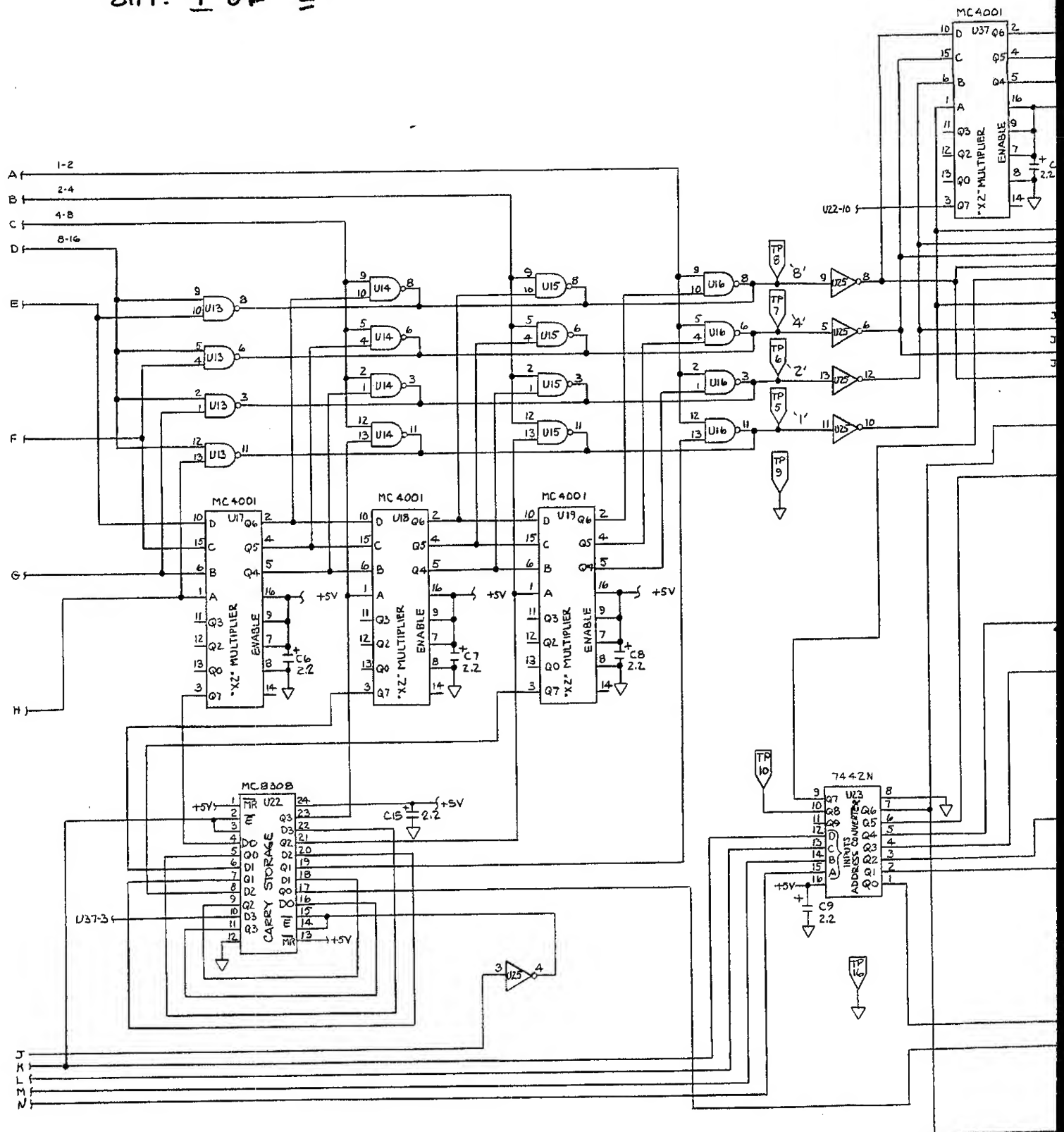


FIG. 8-14a
SHT. 3 OF 2

6160B

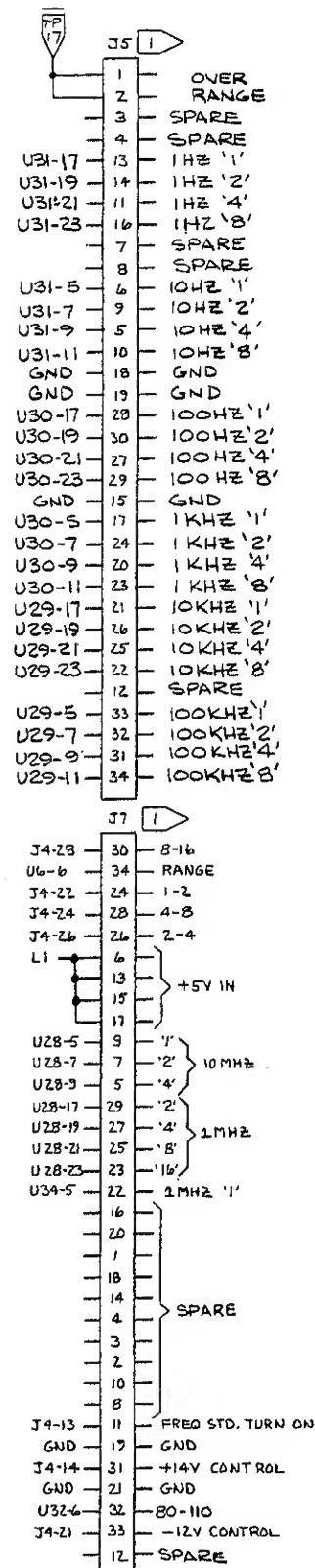
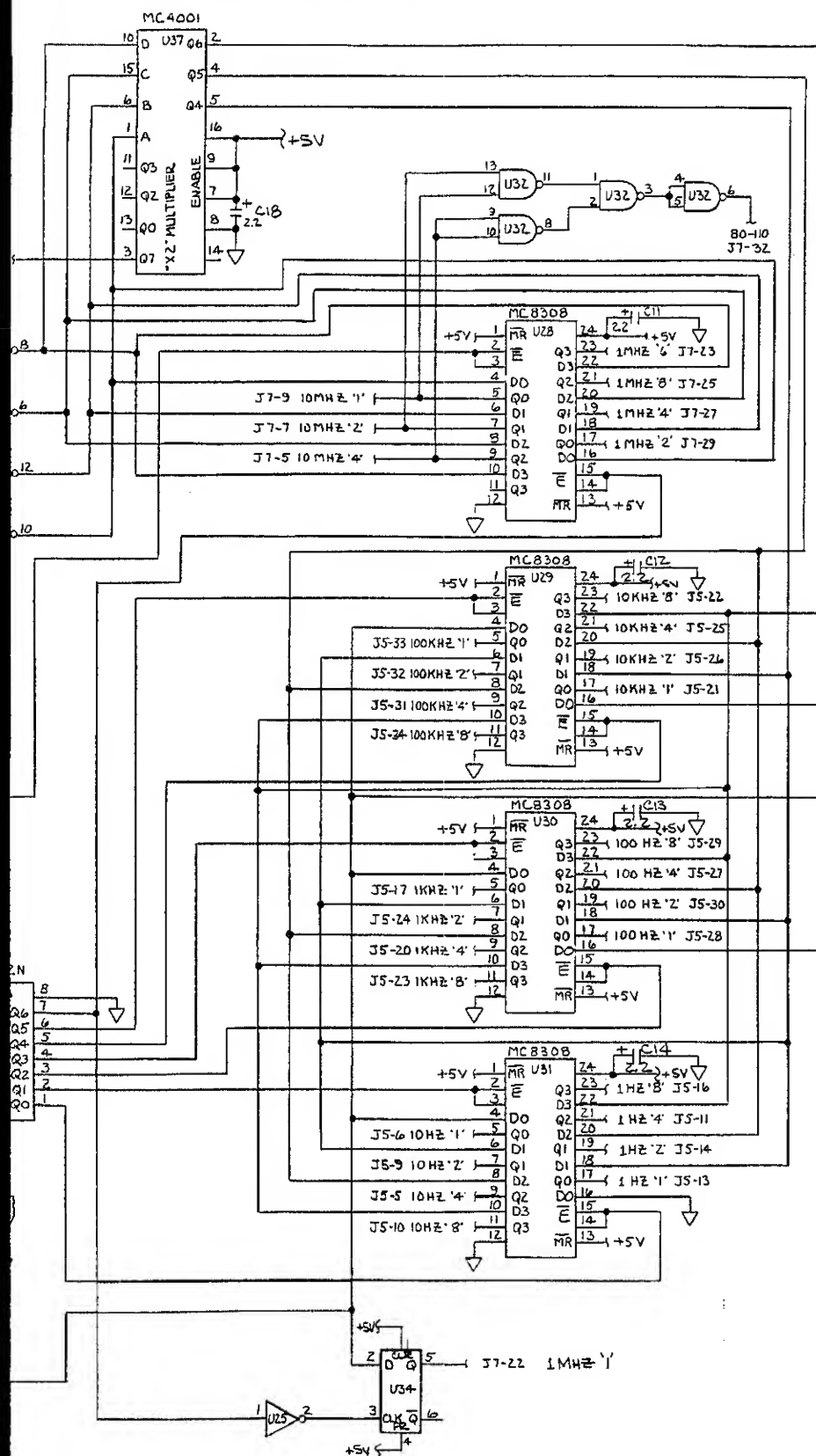


FIGURE 8-14 (2 of 2) A10 COMPUTER PCB
ASSEMBLY (6160B-1012)

FIG. 8-15
SHT. 1 OF 2

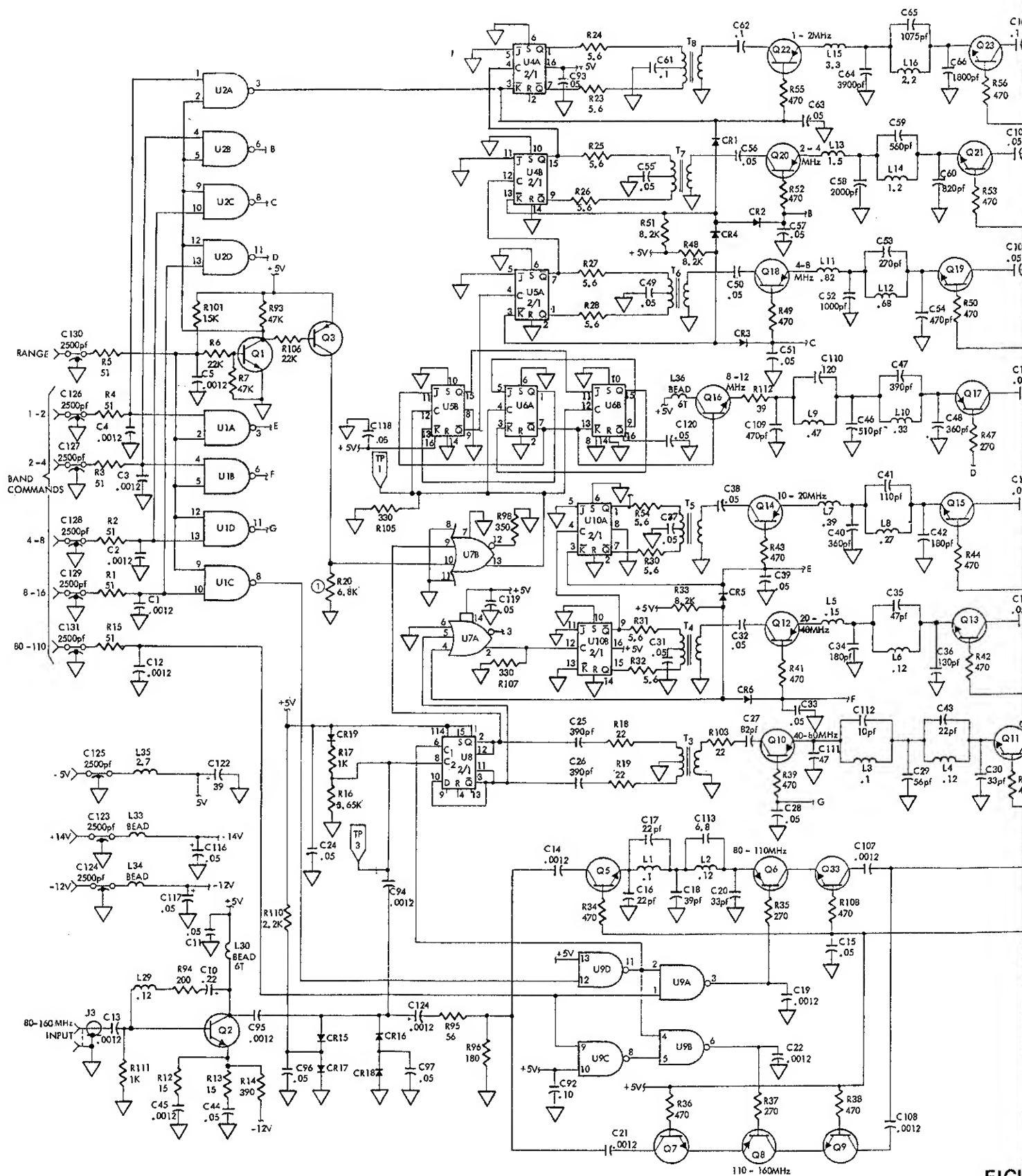
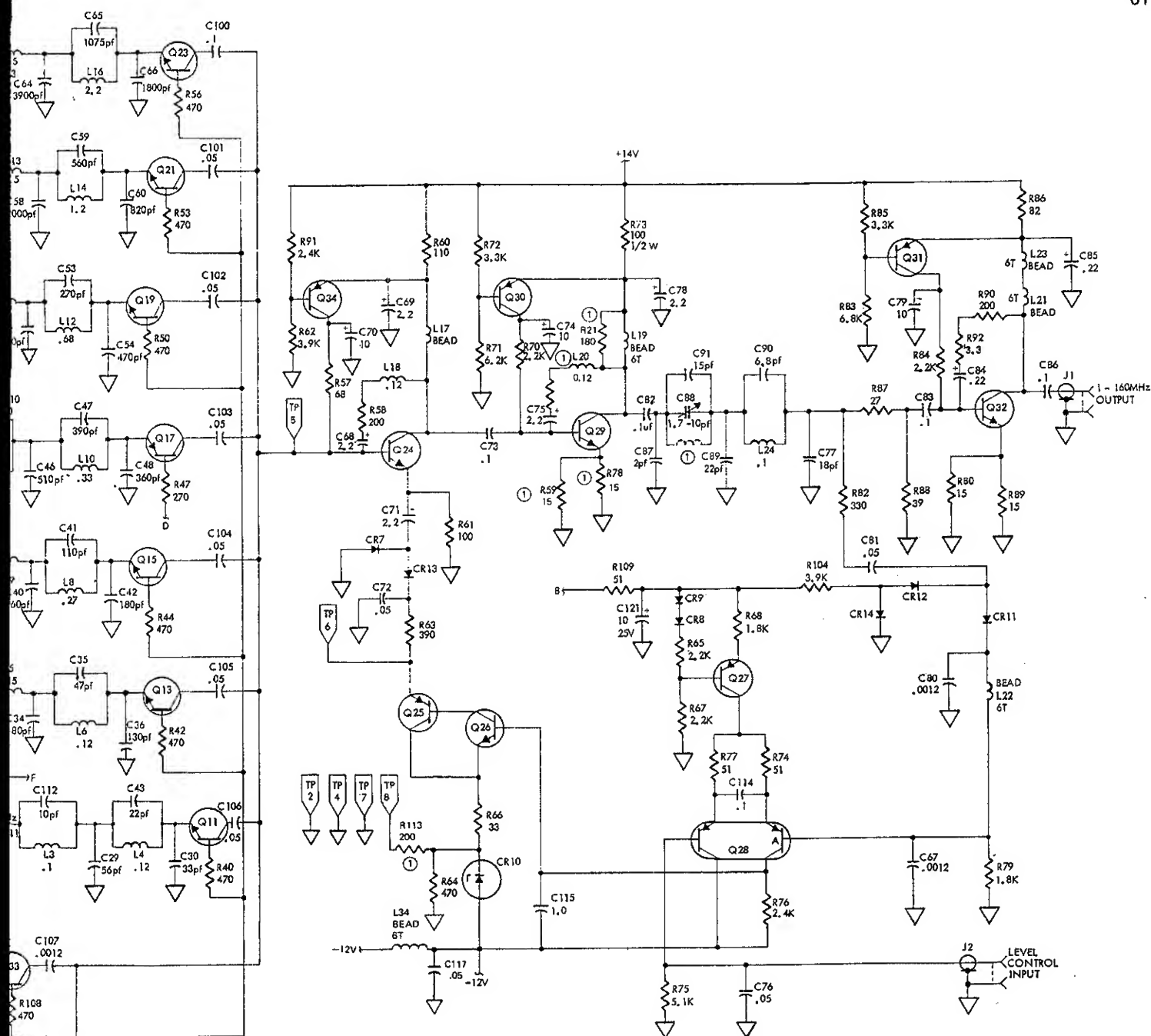


FIG.

FIG. 8-15
SHT. 3 OF 3

6160B



NOTES:

1. ALL CAPACITOR VALUES ARE IN μ F UNLESS NOTED OTHERWISE.
2. ALL RESISTOR VALUES ARE IN OHMS.
3. ALL INDUCTOR VALUES ARE IN μ H.
4. INDICATES PRINTED CIRCUIT BOARD INDUCTOR.
5. DENOTES INTERNAL ADJUSTMENT.
6. * FACTORY SELECTED.

CHANGES:

- ① FOR S/N Q11 THRU Q36:
C87 WAS 10PF
L20 WAS 0.1UH
Q28 WAS NPN
R20 NOT INSTALLED
R21 NOT INSTALLED
R59, R78 WERE 180
R113 NOT INSTALLED

FIGURE 8-15. A11A1 OUTPUT DIVIDER
PCB ASSEMBLY (6160A-1011)

FIG. 8-16
SHT. 1 OF 2

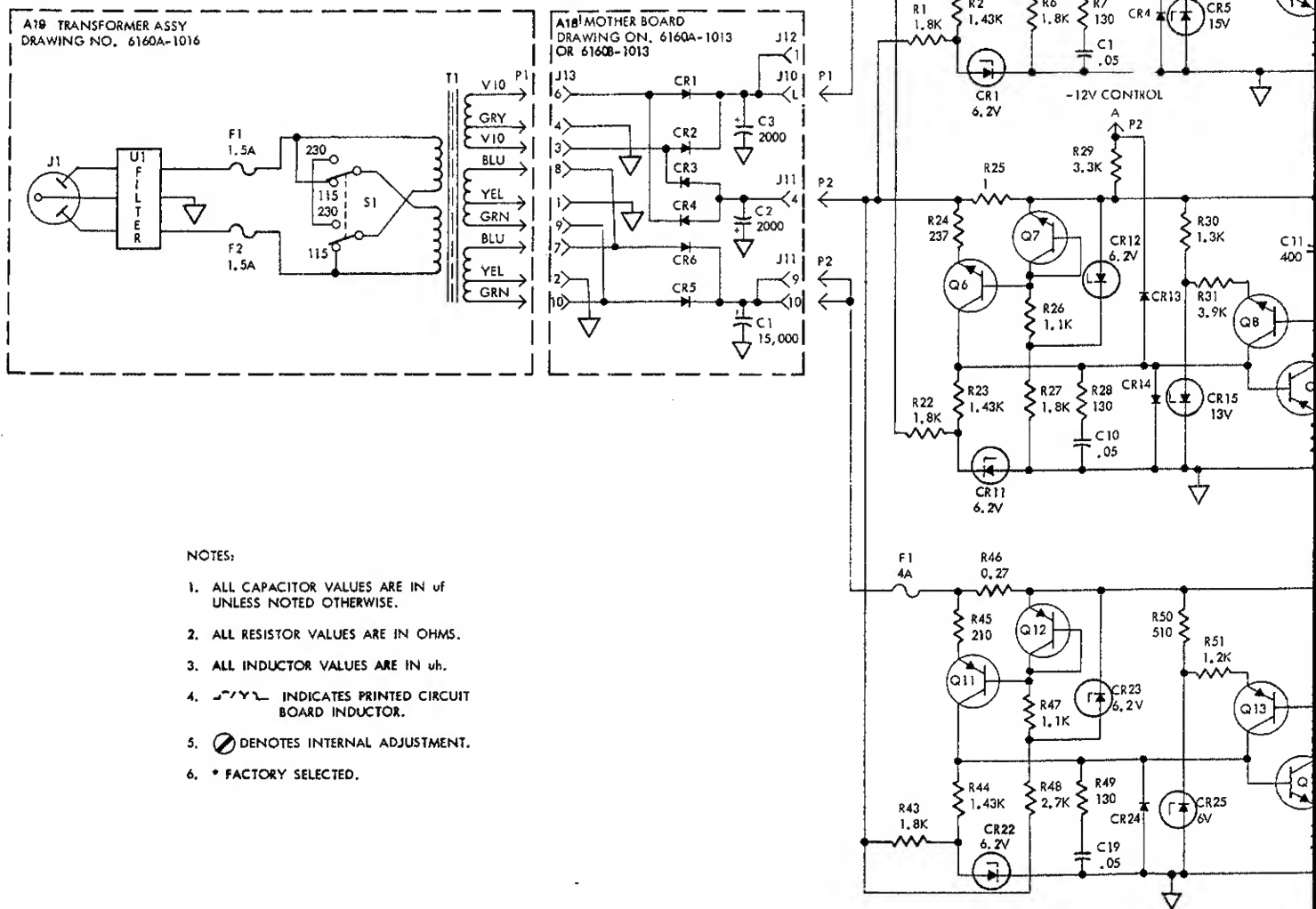


FIG. 8-16
SHT. 3 OF 3

6160B

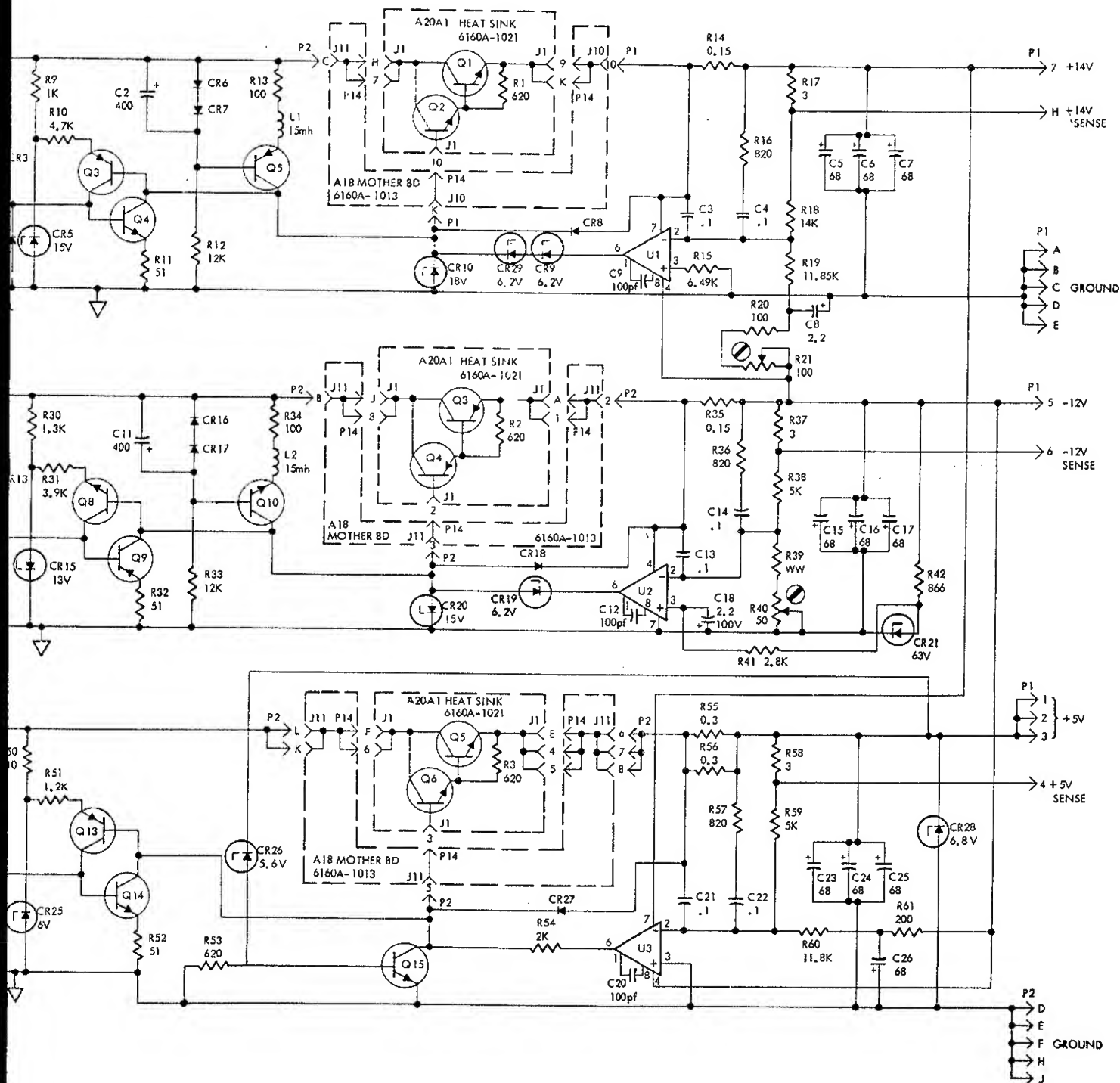


FIGURE 8-16 A12 POWER SUPPLY PCB ASSEMBLY
(6160A-1014)

6160



FIG. 8-17
SHT. 2 OF 2

6160B

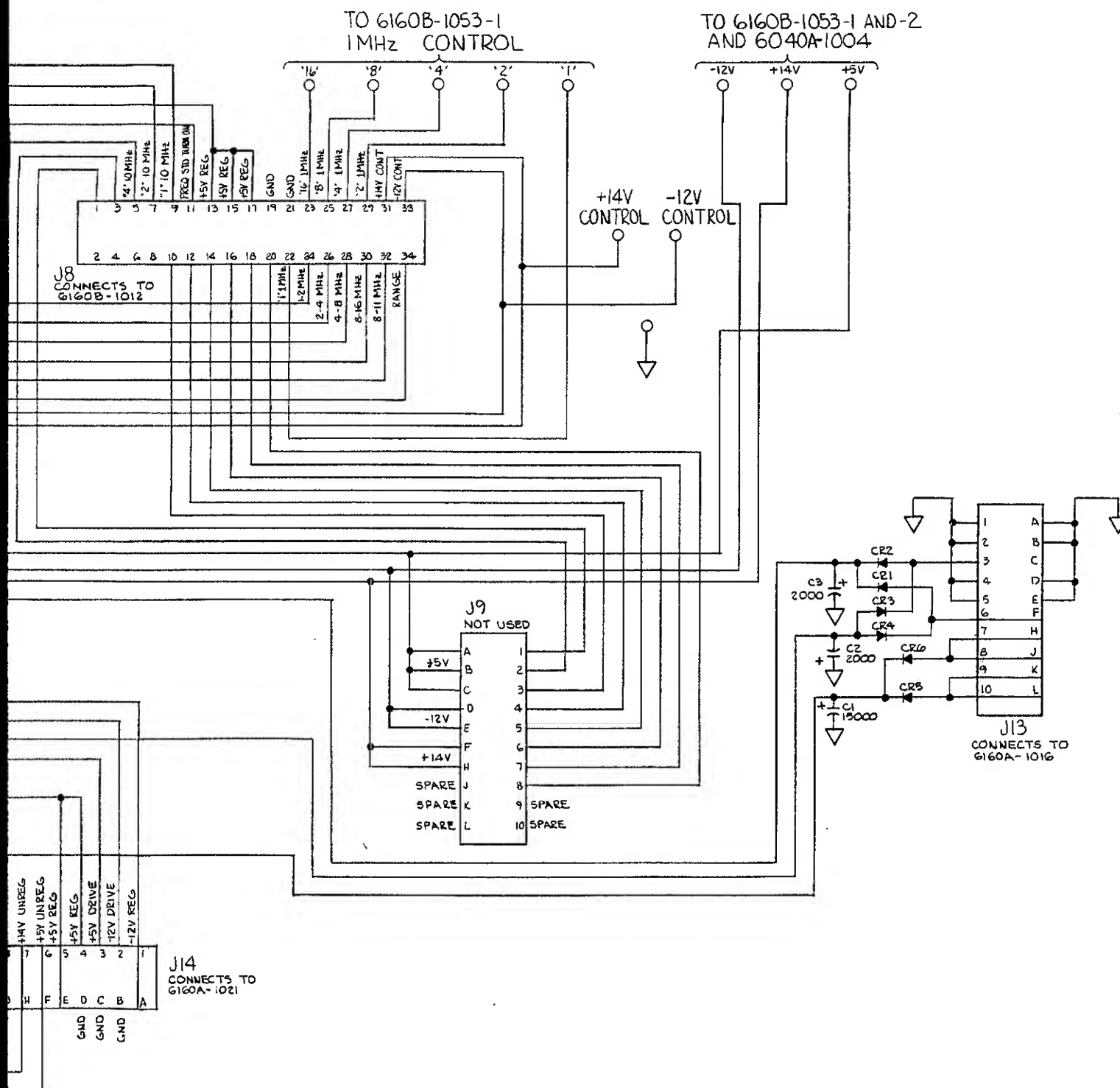
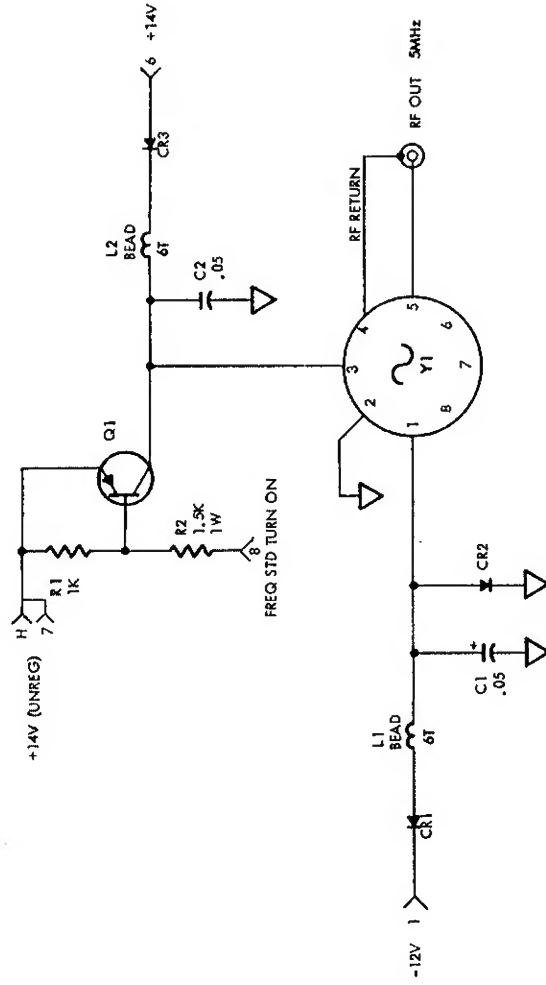


FIGURE 8-17 A13 MOTHER BOARD PCB ASSEMBLY
(6160B-1013)

FIG. 8-18
SAT. 1071

6160B



**FIGURE 8-18 A18 INTERNAL FREQUENCY STAND-
ARE PCB ASSEMBLY OPTION 02
(6160A-1018)**